ECONOMICS OF THE AIRCRAFT INDUSTRY

by

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We have carefully read the thesis entitled
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and recommend its acceptance. In support of this recommendation we present the following joint statement of evaluation to be filed with the thesis.

This thesis applies the modern theory of the firm to the air frame industry. Essentially three basic industries are found to exist, with two of them rather closely interrelated. The military demand is far and away the largest for aircraft, and military interest in the development of large aircraft has played a crucial role in the development of transport aircraft used by airlines. Nevertheless, military aircraft are produced in a market where a monopsonist (the air force) deals in a highly selective way with a very few aircraft companies on terms laid down by the monopsonist. Producers of transport aircraft are fewer than airlines, but both the airlines and the airplane companies are oligopolies, with the result that bi-lateral oligopoly best describes this market. The utility aircraft industry comprises a small number of sellers selling to a large number of buyers, and may be considered s simple oligopoly.

As in all oligopoly studies, the airframe industry, or industries, is a special case, whose behaviour can be understood only after rigorous study of its peculiarities. The airframe industry presents these difficulties in an exceptionally aggravated form and no former economic analysis could be found upon which to build. Mr. Simonson has constructed special theories, tested them against available data, and conducted investigations by personal interview and correspondence. The result is a solid study which makes a substantial contribution to the understanding of this industry which is important both to the military security of the nation and to the level of manufacturing activity. The work is constructed in such a way as to be useful in making policy decisions by government authorities.

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PREFACE

The writing of this thesis does not represent just the efforts of a single person but rather the cooperative efforts of many. Numerous people within the industry have been helpful in providing me with data in addition to that obtained from library sources. In particular, I wish to express my graditude to Mr. Don Black of Douglas Aircraft Company, Mr. R. S. Johnson of North American Aviation, and Mr. Ernest A. Foster of Lockheed Aircraft Corporation. Each of these gentlemen provided me with useful information in interviews with them. Mr. Foster was especially helpful in providing me with both published and unpublished data from Lockheed's files. Mr. F. A. W. Stiefler of the Aircraft Industries Association supplied me with important information in an interview and several telephone conversations.

Although information was requested from every United States airframe producer on one or more occasions, not all producers responded. Credit is due to the personnel of the airframe companies who went to the trouble of supplying me with answers to questionnaires and correspondence. Mr. Cecile Hamilton, managing editor of Flying, has supplied copies and given permission to use in the thesis the illustration "Evolution of USAF Aircraft 1907-1957" from the

February, 1957, issue of Flying. Acknowledgment is also made to Mr. Jefferies, the artist of this very informative illustration.

The members of my dissertation committee, Professor Douglass C. North, Professor James A. Crutchfield, and Professor Dean A. Worcester, Jr., are very deserving of appreciation for the parts they have played in my graduate training and for their special efforts in connection with the dissertation. Professor Worcester, as chairman of the committee, has been especially helpful in guiding this project to completion. He had the additional burden of carrying on much correspondence with me because the thesis was written off-campus. For such considerations I can only say that I am most grateful.

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INTRODUCTION

The purpose of this study is to arrive at an explanation of the economic operation of the aircraft industry. The economic literature abounds with comprehensive accounts of the operation of such industries as the automotive, steel, agricultural, textile, chemical, cigarette, the various transport industries, and many others, yet there is no detailed industry study which is concerned with an explanation of the economics of the aircraft manufacturing industry. This study has been undertaken, therefore, to augment the economic literature of industry studies as it pertains to the aircraft industry and, more specifically, to the airframe industry.

The importance of this study lies in the significance of the aircraft industry itself. In the first place, as was true during World War II, the aircraft industry today is the largest manufacturing employer in the United States and employs directly almost five per cent of the country's total manufacturing manpower. Secondly, and even more significant, the aircraft industry plays a vital role in providing the necessary products for our national defense and the defense of the free world. Finally, the industry provides transport media upon which the economic system is becoming increasingly dependent for efficient operation. For these reasons it is essential that the economic func-

tioning of this industry be understood in order to make sure that it operates in the best interests of society.

The approach of the thesis has been as follows. Chapter One deals with the history of the growth of the industry. The basic framework used throughout most of this chapter has been to trace the historical factors which have led to the changing demand for aircraft which in turn have led to changing profit expectations in the industry. This is followed by a description of how the industry has responded in terms of changes in output and sales for each of the periods discussed up to the present. The policy of the Federal Government with respect to the industry admittedly has played an extremely important part in conditioning this growth historically. Although its role in relation to the industry's growth is developed in Chapter One, public policy is treated in greater detail in Chapter Five. An important function of the first chapter is to provide a background for the more detailed analysis of the succeeding chapters.

Chapter Two is devoted to explaining the principal divisions of the market for aircraft and the nature of the products produced. Attention is given to the structure of the market with reference to the number and relative importance of buyers of products within the principal market divisions.

The organization and technology of production of the industry are discussed in Chapter Three. The principal concern of the chapter is with the airframe industry because

it represents the largest segment of the industry and produces the final product. Particular attention is paid to the extent to which concentration exists in the airframe industry and the reasons for it. The technology of production is discussed with reference to how it has been conditioned by the concentration of output.

In Chapter Four the competitive practices of the airframe industry are described. These practices are explained in terms of how they are conditioned by the industry structure denoted in the two previous chapters.

The fifth chapter is concerned with government policy pertaining to the industry. Although attention is given to its development historically, the emphasis of the chapter is on recent government policy.

The final chapter summarizes the major features of the study and draws several conclusions concerning the observations which have been made with respect to how the industry functions in the interests of society.

CHAPTER I

INDUSTRIAL GROWTH, 1909-1957

Early Developments in the Science of Flight

Ancient and medieval experiments.--The earliest legend of an attempt by a human to fly is dated as far back as the third millenium B.C. when the Chinese Emperor Shun attempted to escape from captivity in a tower by means of two large reed hats used like parachutes.[1] Since then until sustained human flight became a reality countless attempts to fly were made by man. The science of flight was born in comparatively recent times. Virtually nothing was derived from antiquity to develop it. In fact, it appears that no attempt was made to approach the development of flight on a scientific basis until Roger Bacon (1214-1292) became interested in flight.[2] In his Secrets of Art and Nature, written about 1250 and translated in 1659, Bacon stated:

> It's possible to make Engines for flying, a man sitting in the midst thereof, by turning onely about

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[1] M. J. B. Davy, Interpretive History of Flight (London: H. M. Stationary Office, 1937), p. 207.

[2] Perhaps it is fortunate that Bacon was among the first to direct his attention to the problems of flight since he is usually recognized as the father of the Scientific Method.

> an instrument, which moves artificall Wings made to beat the Aire, much after the fashion of a Bird's flight.[3]

He admitted that he had never seen an instrument which could fly but he did say he knew the name of the man who had invented one.[4]

Although Bacon's views were remarkable in that he spoke of application of mechanical apparatus to propell an aircraft, Leonardo da Vinci (1452-1519) was probably the first actually to record some of the rational principles on flight which resulted from his experiments and observations.[5] His main contributions to the subject of flight were contained in his notebook Sul volo degli Uccelli (On the Flight of Birds) which was written in Florence in 1505 but not made public until 1797. He observed the relation between the center of gravity and the center of pressure in the maintenance of equilibrium in flight in addition to other stated principles. It was the solving of this problem of equilibrium and balance which later became the major accomplishment of the Wrights enabling sustained flight. Da Vinci made numerous sketches of experimental models of aircraft manually propelled and like the model suggested by Bacon but without an engine or a propeller. His experimenta-

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[3]John William Ransom Taylor, A Picture History of Flight (New York: Pitman Publishing Corp., 1956), p. 9.

[4]Davy, op. cit., p. 22.

[5]Ibid., p. 12.

tion with them was unsuccessful.[6] That which appears to have been the most important advance was the scientific method in which da Vinci conducted his research:

> He observed and studied animals who were capable of flight, their anatomy and their movements under different conditions, and also the medium in which they operate. He searched for the cause of every observed effect, and from his deductions he made a statement of basic principles--a simple statement of the law of reactions as applied to flight--which is unique in that it is the first.[7]

In A Treatise on the Flight of Birds, Da Vinci wrote:

> A bird is an instrument working in accordance with mathematical law, which instrument it is within the capacity of man to reproduce.[8]

With this statement he removed the problem of flight from the realm of medieval magic and the supernatural to the plane of natural science. Now man had first to acquaint himself with the mathematical laws which governed flight and then he could go about constructing a device, which in accordance with these laws, would be capable of flight. In addition to his contributions of approach to the investigation and the principles pertaining to equilibrium of a flying body which he discovered, da Vinci also left drawings of an aerial propeller of practical design, a parachute,

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[6]Chelsea Fraser, The Story of Aircraft (New York: Thomas Y. Crowell Co., 1933), pp. 240-42.

[7]Davy, op. cit., p. 25.

[8]C. L. M. Brown, The Conquest of the Air (London: Oxford University Press, 1927), p. 11.

and a helicopter.[9] The latter represents the first known application of the screw (propeller), or helix, for use in the air.[10]

First successful flight of a human.--No further major advances were made in developing the science of flight until Joseph and Etienne Montgolfier of Annoy, France, invented the balloon capable of carrying humans aloft.[11] On October 15, 1783, Pilatre de Rozier made the first ascent of a human in the lighter-than-air craft of the Montgolfiers which used hot air from the burning of straw as a lifting medium.[12] Later that year a French physicist Jacques Alexander Cesar Charles and a friend made an ascent using hydrogen gas as a lifting medium. The development of lighter-than-air craft continued until the first dependent power-driven dirigible balloon was built by Henri Gifford in 1852. Still later in 1900, Ferdinand von Zeppelin built the first rigid power-driven, lighter-than-air craft. But the evolution of balloons and dirigibles had little if any direct effect in pioneering the early development of the airplane. Of all the early contributors to the development of the airplane, there is only one person, Alberto Santos-Dumont, who had any experience in lighter-than-air craft.[13]

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[9]Fraser, op. cit., p. 240.

[10]Davy, op. cit., p. 25. [11]Taylor, op. cit., p. 10.

[12]Davy, op. cit., p. 40.

[13]Richard Shelton Kirby et al., Engineering in History (New York: McGraw-Hill Book Co., 1956), pp. 415-16.

There is apparently little evidence, if any, that those who helped solve the problems of flight of the airplane derived anything from the experiences of those who developed balloons and dirigibles.

The first successful glider.--While advances were being made in the development of lighter-than-air craft, an Englishman, Sir George Cayley (1773-1857) added to the basic principles of aeronautics. He built the first successful glider, a biplane on which were positioned rigid wings and a tail similar to that of the modern aircraft. He used cambered wings, as da Vinci had previously, thereby employing the principle of the air foil.

The first flight of an airplane.--Cayley's discoveries were utilized later by two of his countrymen, William Samuel Henson (1805-1888) and John Stringfellow (1799-1883). Henson and Stringfellow built the Aerial Stream Carriage which was the first engine-driven aircraft constructed.[14] It was a monoplane, with the fuselage below the wing, a tail, nose-wheel undercarriage, and two pusher propellers. Henson's and Stringfellow's plane never flew, but after Henson abandoned further work on its improvement Stringfellow carried on alone until he finally designed a steam engine which was light and yet powerful enough to lift the airplane. He incorporated the engine in a ten foot model airframe which in 1848 became the first heavier-

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[14]Taylor, op. cit., p. 17.

than-air powered airplane to fly.[15] The airplane flew only a distance of forty feet on its first flight inside a factory building. Later it flew 120 feet outside. Because Stringfellow could get no one to finance him in developing a full sized machine capable of carrying a man, he was forced to abandon his efforts in advancing the science of flight.

First human flight in a power-driven airplane.--Stringfellow's success was followed by numerous claimants for the title of first to fly in a power-driven airplane. The Russians claim that a Mr. Mozhaisky flew successfully in 1882 in a large monoplane with three steam-driven propellers.[16] In France, Clement Adler (1841-1925) left the ground in a power-driven airplane on the 9th of October in 1890 for about fifty yards. In England Sir Hiram Maxim (1840-1916) made a brief flight in 1894 in a huge three and one-half ton airplane powered by two 180 horsepower engines. These attempts demonstrated that human flight was possible in power-driven airplanes--their common shortcoming was that they were uncontrolled. The problem of controlling flight remained for the glider-makers to solve.

First man-carrying glider.--The German Otto Lilienthal (1848-1896) was apparently the first builder of

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[15] Ibid., p. 12.

[16] Ibid., p. 21. Outside Russia this claim has not been recognized.

a successful glider. Between 1886 and 1896 he made more than two thousand successful glider flights travelling distances up to a quarter of a mile at heights up to seventy-five feet.[17] He published the findings of his experiments in his Problems of Flying and Practical Experiments in Soaring. His experiments proved the superiority of curved wing surfaces in flying, a concept previously deduced by da Vinci and tested by Cayley.

Percy Pilcher (1866-1899) in England and Octave Chanute (1832-1910) in the United States were among those who carried on glider experimentation where Lilienthal had left off. Pilcher made the same fatal mistake as had Lilienthal before him--that of relying on balancing and controlling the flight of his glider by the shifting of body weight. Chanute carried on countless experiments directed toward improving the control of the glider and to correct for loss of balance by adjustment of the glider itself rather than that of maintaining balance by shifting the weight of the body, or center of gravity, to coincide with the altering center of pressure as Lilienthal and Pilcher had relied on before him. This somewhat greater degree of stability inherent in the machine itself he achieved by making the wing surfaces adjustable so that the center of pressure would be restored.[18] In 1894 Chanute's book

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[17] Ibid., pp. 20-21.

[18] Brown, op. cit., p. 72.

Progress in Flying Machines was published. In it was the most comprehensive survey of practically all the experiments and ideas which had developed in connection with mechanical flight. This proved to be a valuable record for those engaged in future experimentation.

While Chanute was conducting his experiments, Professor Samuel Pierpont Langley (1834-1906) of the Smithsonian Institution also was directing his attention to experimenting in aerodynamics. Langley designed and built a man-carrying, engine-powered airplane which some years after his death was demonstrated to be perfectly capable of flight. His investigations of air resistance to the plane and the various properties of the plane were so thorough that he was able to express the results in definite mathematical terms. In 1896 Langley constructed and tested two model "aerodromes," as he referred to airplanes, one of which was so successful that it flew a distance of 4,200 feet at a speed of about twenty-five miles per hour.[19] Although this was a pilotless airplane, it was by far the most successful experiment conducted with power-driven aircraft up to that time. Langley encountered very unfortunate difficulties in flying subsequent man-carrying models, not because the aircraft were incapable of flight but because the launching devices which he employed in

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[19]Davy, op. cit., p. 111.

each instance damaged the aircraft before it was airborne.[20]

The Wright Brothers.--Of all the contributions to the science of flight that of Wilbur and Orville Wright was the greatest. It was they who developed aircraft which were power-driven and capable of being mechanically controlled in flight by their operator. The Wrights had solved the problems of equilibrium and balance in flight which previously had been the number one deterrent to achieving sustained human flight. The technological achievement of the Wrights is so monumental it is interesting to note how they realized their success.

The Wrights' interest in flight was first aroused in 1871; Wilbur was then eleven and Orville seven years old, when their father gave them a toy flying machine, powered by a twisted rubber band, which was designed by the Frenchman Alphonse Penaud.[21] Their schooling did not help much to advance their knowledge because neither completed high school. Their mother's side of the family had an engineering background which may perhaps have contributed to their scientific talent. Their father, a Bishop in the United Brethren Church, is said to have been enccuraging of whatever intellectual pursuits they sought to undertake.

From 1893 the Wrights were in the bicycle business

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[20]Brown, op. cit., p. 85.

[21]Orville Wright, How We Invented the Airplane, ed. by Fred C. Kelly (New York: David McKay Co., 1953), p. 6.

and it was from this that they evidently derived the capital with which they financed their aeronautical experiments. In their spare time they read books on ornithology in order that they might better understand how birds could fly. In 1896 they read a brief account of the death of Lilienthal and of his accomplishments in gliding. It is said that it was he who inspired the Wrights the most.[22] In 1899 the Wrights sent to the Smithsonian Institute for: Problems of Flying and Practical Experiments in Soaring by Lilienthal; Story of Experiments in Mechanical Flight by Langley; Empire of the Air by Mouillard; Progress in Flying Machines by Chanute; Experiments in Aerodynamics; and the Aeronautical Annuals of 1895, 1896, and 1897. From their readings the Wrights were quick to assess that which had been accomplished and that which remained to be done before a manned power-driven airplane could be successfully operated. Wrote Wilbur:

> The difficulties which obstruct the pathway to success in flying-machine construction are of three general classes; (1) those which relate to the construction of sustaining wings; (2) those which relate to the generation and application of the power required to drive the machine through the air; (3) those relating to the balancing and steering of the machine after it is actually in flight.[23]

He observed that the first two of these difficulties had been overcome essentially but the third remained:

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[22] Ibid., p. 7.

[23] Brown, op. cit., p. 92.

> . . . when this one feature has been worked out, the age of flying-machines will have arrived, for all other difficulties are of minor importance.[24]

Their practical experiments with gliders began in 1900 at Kill Devil Sand hills, near Kitty Hawk in North Carolina, where steady winds were favorable for gliding. Chanute encouraged and advised them during their work and became a close friend. These first experiments met with little success until it was finally deduced that calculations of previous experimenters, notably Cayley, Lilienthal and Langley, on which they had relied, were often inaccurate and could not be depended upon to yield desired results. As Wilbur said:

> Having set out with absolute faith in the existing scientific data, we were finally driven to doubt one after another, till finally, after two years of experiments we cast it all aside and decided to rely entirely on our own investigations. Truth and error were everywhere so intimately mixed as to be indistinguishable.[25]

To secure the accurate aerodynamic data which they needed, in 1901 they constructed a wind tunnel in which they conducted numerous tests with over two hundred types of winged surfaces, during which they carefully and methodically recorded each result.[26] With the more accurate data the Wrights were able to build and test the first successful glider capable of being mechanically controlled and balanced. The innovations enabling this truly great

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[24] Ibid. [25] Ibid., p. 96.

[26] Ibid., and Kirby et al., op. cit., p. 116.

accomplishment were the adjustable rudder and the warping of the wings. In effect, the Wrights had invented the adjustable rudder and had discovered the aileron principle.[27] That which remained was to supply their flying machine with motor power.

Progress was being made in engine development over that of the steam engine along the lines of reducing the weight per horsepower, which was an important consideration for powered flight. The invention of the four-stroke-cycle internal combustion engine in 1876 by Nikolaus Otto was an important advance.[28] It should be recalled, however, that Stringfellow, Ader, Maxim, Langley, and others had achieved power-driven flight even with less efficient and more cumbersome steam engines. Subsequent improvements on the internal combustion engine by Gottlieb Daimler in 1883 succeeded in raising its revolutions per minute to the point where its application to the automobile was practicable.[29] But even Daimler's engine was far too heavy to be applied to aircraft. The belief of the need for a lighter and more powerful engine forced Langley to sponsor the development of such an engine. He did this after

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[27]Wright, op. cit., p. 23.

[28]Kirby et al., op. cit., p. 415.

[29]"Internal Combustion Engines," Encyclopedia Americana, XV (1956 ed.), 225.

unsuccessful attempts to get the engine developed by an engineering firm.[30] Langley's able assistant, Charles Manly, succeeded in this assigned task by evolving a five cylinder, water cooled, radial engine which developed 52 horsepower and weighed 207 pounds--which meant it weighed approximately four pounds per horsepower.[31] This was truly an amazing achievement.

The Wrights approached the problem of obtaining motor power for their flying machine with the same zeal as they had that of achieving equilibrium in flight but with a belief that the major tasks already had been accomplished.[32] With unfavorable responses from automotive manufacturers,[33] the Wrights faced the same task of engine development as Langley. Within one year, with the aid of their assistant Charlie Taylor, they succeeded in designing and constructing a four cylinder engine which weighed 170 pounds and produced twelve horsepower,[34] or a weight of approximately 14 pounds per horsepower. Even for a trained and experienced engineer Manly's feat was notable; but for unschooled and

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[30]Archibald Black, The Story of Flying (New York: McGraw-Hill Book Co., 1940), p. 34.

[31]Clayton Knight, The Story of Flight (New York: Grosset and Dunlop, 1954), p. 34.

[32]Brown, op. cit., p. 92.

[33]National Aviation Education Council, "December 17--A Day to Remember," Skylights, 4 (December, 1957), 2.

[34]Ibid.

inexperienced engineers, as were the Wrights, their accomplishment, even though their engine was inferior to Manly's, should be considered almost on a par with their achievement of securing controlled equilibrium in flight. They even built their own propellers, which had an estimated efficiency of 66 per cent.[35] On their first plane were two propellers running in opposite directions to equalize the effects of torque. It was this engine which they fitted to a new biplane flying machine built similar to their successful glider of 1902. Wilbur Wright stated concerning the first of their four flights on the 17th of December in 1903 at Kill Devil Sand Hill:

> . . . the first in the history of the world in which a machine carrying a man had raised itself into the air by its own power in free flight, had sailed forward on a level course without reduction of speed, and had finally landed without being wrecked.[36]

This flight covered a distance of only 100 feet and lasted only 12 seconds. The duration and distance increased with successive attempts that day until the fourth flight covered 852 feet and lasted 59 seconds.

The Wrights had overcome the major obstacles of mechanical flight. That which remained was to improve upon the aerodynamic and structural characteristics of their machine. "The history of the airplane is essentially the history of the engineering solutions of the twin problems

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[35]Wright, op. cit., p. 52.

[36]Brown, op. cit., p. 101.

of motive power and of aerodynamics."[37] Even the great captains of the aircraft industry acknowledge that their contributions have been conservative relative to that of the Wrights. When Donald Douglas received the Collier Trophy for the development of the DC-2 he observed:

> There is nothing revolutionary in the airplane business. It is just a matter of development. What we got today is the Wright brothers' airplane developed and refined. But the basic principles are just what they always were.[38]

This view had not changed fourteen years later when John K. Northrop noted:

> The coming age of aviation has been dependent on two basic concepts. The first of these is the understanding and improvement of the aerodynamic and structural characteristics of the airplane itself; the second is the development of an engine having sufficient power for a tolerable weight to propell the airplane. . . . the essence of aeronautical history has consisted solely in improvement in these two basic elements which were successfully combined in the Wright brothers' experiments.[39]

Although it is generally conceded that Lilienthal, Chanute, and Langley laid the foundation for the success of the Wrights, their success culminated several centuries of experimentation by literally hundreds of experimenters. The motivations, as well as the methods of research and experimentation, of those who made sustained human flight

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[37] Kirby et al., op. cit., p. 415.

[38] Frank Cunningham, Sky Master, the Story of Donald Douglas (Philadelphia: Dorrance and Co., 1943), p. 253.

[39] John K. Northrop, Aviation History, 1903 to 1960 (Washington: U.S. Library of Congress, 1949), p. 7.

possible, were in every sense scientific with apparently little thought to economic gain. But now that the airplane was a reality and its commercial possibilities became evident, the aircraft manufacturing industry could be developed.

The Birth of the Industry to 1914

Once the airplane was invented, there was widespread speculation that aircraft manufacturing would be a very profitable business. Even the Wright brothers, who previously were concerned with proving that flight was a possibility,[40] were motivated by the profit prospects in the industry. In reply to a request of the Ordnance Board of the United States War Department, on May 31, 1907, the Wrights submitted a formal proposal offering one of their flying machines. Their requested price was $100,000.[41] Considering that the aircraft they proposed was not substantially different from their 1903 model in terms of construction cost and that the cash outlay for building the 1903 model was less than $1,000 (including their railroad fare from Dayton, Ohio, to Kitty Hawk, North Carolina, and

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[40] Orville Wright is quoted as having said: "At the time we first flew our power plane we were not thinking of any practical uses at all. We just wanted to show that it was possible to fly." (Wright, op. cit., p. 78.)

[41] The specifications were that the machine was capable of carrying two men, 200 kilometers at not less than 50 k.p.h. Eaton Manufacturing Company, A Chronicle of the Aviation Industry, 1903-1947 (Cleveland: Eaton Manufacturing Co., 1948), p. 8.

back),[42] this proposed price allowed for a considerable margin of profit. The War Department did not accept their proposal but later that year the United States Army Signal Corps advertised for competitive bids on an airplane. The Wrights were among the three parties who submitted bids. Their bid was successful and on February 10, 1908, they signed a formal contract with the Signal Corps for the sale of an aircraft for $25,000.[43] In 1908 they realized even greater returns when they sold patents to a French company for $100,000.[44] They went on to organize a German company in 1909 and an English one in 1913.

Although the Wrights applied for a patent on their flying machine early in 1903,[45] enough variations in the structure of an airplane were believed possible so as not to discourage others from entering the industry. The Curtiss Motor Vehicle Company was formed in Hammondsport, New York, in November, 1907, to manufacture airplanes as

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[42] Ibid., p. 7.

[43] Ibid., p. 8. It is interesting to observe that when the Wrights were placed in a competitive situation, their asking price declined by 75 per cent. The Army also signed contracts with the other two bidders, A. M. Herring and J. F. Scott. Fred Hamlin and Eleanor Thayer Miller (eds.), The Aircraft Year Book, 1955 (Washington: The Lincoln Press, 1956), p. 386.

[44] Elsbeth E. Freudenthal, The Aviation Business (New York: The Vanguard Press, 1940), p. 20.

[45] They applied for a patent on March 23, 1903, and were issued it on May 22, 1906. Hamlin and Miller, op. cit., pp. 385-86.

well as other motor vehicles.[46] The Wright Company was not founded formally until November of 1909 with the factory located in Dayton, Ohio. The Glenn L. Martin Company was organized about the same time in Santa Ana, California.[47] Actually, Glenn H. Curtiss is credited with having built and sold the first "commercial" airplane in the United States.[48] Although these three companies stand out in early aircraft manufacturing, their prominence could not obscure the tremendous profit-response in the rest of the industry. In the year that the Wrights sold their first airplane to the Army, it has been observed that more than seventy-five individuals and firms were experimenting in and constructing airplanes.[49] By 1911, and in that year alone, it was estimated that more than 750 airplanes were built by private individuals, and no less than 66 companies organized to manufacture airplanes.[50] In 1912, forty-four more new aircraft manufacturing concerns were organized and in 1913 at least twenty-nine more.[51] Despite improvements in aircraft performance,[52] and the increased popularity of

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[46] Eaton, op. cit., p. 8.

[47] These three organizations, or at least vestiges of them, are among the few to survive to the present day among those organized during the first decade of the industry.

[48] Eaton, loc. cit. [49] Ibid., p. 9.

[50] Ibid., p. 13. [51] Ibid., pp. 14-15.

[52] On December 28, 1913, G. Legagneux established a new record when he ascended to an altitude of 20,250 feet. That same year M. Prevost broke the speed record by travelling

of flying, the expectations of the early manufacturers were not justified. Few aircraft were sold for either commercial or military purposes. Lawsuits over the infringement of patent rights between the Wright brothers and other manufacturers, notably the Herring-Curtiss Company and Glenn H. Curtiss,[53] made producers generally apprehensive lest product development would become a liability to them. The patent lawsuits were in most cases settled by 1914. The customers of the industry prior to 1914 were "limited to a few exhibition pilots and sportsmen, with an occasional small order from the Army and Navy."[54] But with impending war in Europe, small orders for American aircraft and aircraft engines were beginning to be received as early as 1912 from Russia, Roumania, Japan, and even Mexico.[55] In 1913 the United States exported 29 aircraft having a value of $81,750. The value of all aeronautical exports of that year was $107,552, which included the value of the aircraft as well as separate engines and other aircraft parts. The following year, 1914, thirty-four aircraft were exported having a value of $188,924 and the total value of all aeronautical exports

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129 miles per hour. A. Fournier broke the endurance record when on September 1, 1911, he remained aloft for over 11 hours. Freudenthal, op. cit., p. 12.

[53] Ibid., pp. 14-15.

[54] Howard Mingos, Birth of an Industry (New York: W. B. Conkey Co., 1930), p. 10.

[55] Eaton, op. cit., p. 14, and Freudenthal, op. cit., p. 20.

of that year was $226,149.[56] Aircraft exports in these years represented 68 percent of the aircraft sold for there were in total only 43 aircraft sold in 1913 and 49 in 1914.[57] The demand for aircraft for commercial aviation had not yet developed, and the Government's demand for aircraft was growing slowly with the increasing recognition of the potential of a military air arm.[58]

World War I, 1914-1918

The aircraft industry experienced a period of tremendous growth during World War I. Table 1 shows that prior to 1917 the increase in demand was principally for exports, from 34 aircraft sold in 1914 to 269 in 1916. In 1917 and 1918, when the United States was actively in the war, by far the greatest percentage of sales was to the United States Government and exports were relatively a much less important component of total demand, although the number and value of all aeronautical exports, including engines and other aircraft parts, rose significantly from $226,149 in 1914 to $9,084,097 in 1918.

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[56] Data for the years 1913 and 1914 were obtained from the Civil Aeronautics Administration, CAA Statistical Handbook of Civil Aviation, 1957 (Washington: Government Printing Office, 1957), p. 65.

[57] Ben S. Lee (ed.), Aviation Facts and Figures, 1957 (Washington: American Aviation Publications, 1957), p. 8.

[58] Prior to 1914, the Government had purchased only 42 aircraft. From 1909 to 1914 total cash appropriations for military aviation were approximately $290,000. Ibid., pp. 8 and 28.

TABLE 1

UNITED STATES AIRCRAFT PRODUCTION AND EXPORTS, 1914-1918

Year	Aircraft Produced	Aircraft Exported	Percent Exports of Production	Value of Aircraft Exports	Value of All Aeronautical Exports
1914	49	34	69	$ 188,924	$ 226,149
1915	178	152	85	958,019	1,541,446
1916	411	269	65	2,158,345	7,002,005
1917	2,148	135	6	1,001,542	4,135,445
1918	14,020	20	.1	216,120	9,084,097

Source: CAA Statistical Handbook of Civil Aviation, 1957.

After the war got underway in Europe, the Allies appealed to the United States for 25,000 airplanes.[59] At the time the United States had an estimated capacity to produce only 2,500 airplanes. Even by 1917 the United States had only an estimated capacity to produce 7,200 airplanes per year. At this time only five companies had ever produced more than ten airplanes,[60] and the largest company,

[59] Mingos, op. cit., p. 15. The Allies wanted the United States to produce parts of aircraft of their own design and ship the parts to them, which they would assemble. The apparent reasoning behind this was that the aircraft manufacturers in France and Great Britain did not want to see the American aircraft industry developed to the extent that it would become a significant post-war competitor. The Americans chose, however, to produce airplanes designed in the United States and to assemble them before shipping, although they did produce airplanes of foreign design too, the most notable of which was the DeHavilland, and did ship aircraft parts. (Ibid., p. 32.)

[60] William Glenn Cunningham, The Aircraft Industry. A Study in Industrial Location (Los Angeles: Lorrin L. Morrison, 1951), p. 37.

Curtiss Aeroplane and Motor Corporation, could produce at capacity an estimated 1,500 aircraft per year.[61] Obviously, the United States was not in a position to meet Allied demands for some time to come and it never did once it began allocating its productive resources to produce aircraft for its own military needs after it had entered the war.[62]

When the United States entered the war on April 6, 1917, it had less than 300 military aircraft.[63] This number seems insignificant when compared to that of 40,000 airplanes which the Joint Army and Navy Technical Board recommended that the United States produce by July 1, 1918.[64] Appropriations for military aviation increased from $1,800,000 in 1916 to $22,500,000 in 1917, the year the United States entered the war. But expansion necessitated an agreement among manufacturers before it could take place. The Wright Company and Curtiss Aeroplane and Motor Company held the important patents in the industry. If aircraft of proven design were to be produced on a large scale, then some type of arrangement had to be made with the basic patent holders. To provide for this, the Manufacturers Aircraft Association

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[61] Preudenthal, op. cit., p. 37.

[62] In fact, during the war, the United States spent $1,139,000,000 on foreign planes and parts. Mingos, op. cit., p. 46.

[63] Fred Hamlin and Eleanor Thayer Miller (eds.), The Aircraft Yearbook, 1956 (Washington: The Lincoln Press, 1957), p. 398.

[64] G. W. Mixter and H. H. Emmons, United States Army Aircraft Production Facts (Washington: Government Printing Office, 1919), p. 7.

was organized on February 15, 1917.[65] Its main purpose was to issue licenses to any member, and any builder could become a member. The license gave the member the right to build aircraft of someone else's design who was also an Association member.[66]

With the patent problem largely out of the way as a factor obstructing expansion of output, the Army and Navy allocated their orders among the more responsible aircraft firms. The largest producers of airplanes during the war were the Curtiss Aeroplane and Motor Company, the Dayton Wright Airplane Company,[67] Standard Aircraft Corporation, and the Fisher Body Company.[68] To get mass production, the techniques of which were previously unknown to the industry, subcontracting was done with the automotive industry.[69] In

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[65] Mingos, op. cit., pp. 17-18.

[66] The principal patent holders, the Wright and Curtiss companies, were members of the Association. At the outset, the patent holders received $200 for each plane produced of their design by a licensee, but the licensee included this $200 in the price charged the Government. Public indignation over the agreement led to a new agreement between the Manufacturers Aircraft Association and the Government which cut the patent royalties in half. (Ibid., pp. 39-40.)

[67] Orville Wright sold out his interests in the Wright Company in 1915 and it was this company which later became merged with the Glenn L. Martin Company to become the Wright-Martin Aircraft Corporation. In 1917 he joined a group of Dayton businessmen and with them organized the Dayton Wright Airplane Company which was formed to build Liberty Motors and the American version of the DeHavilland Airplane.

[68] William Glenn Cunningham, op. cit., p. 37; and Eaton, op. cit., p. 118.

[69] John S. Day, Subcontracting Policy in the Airframe Industry (Boston: Division of Research, Harvard Business School, 1956), p. 17.

fact, of the 300 plants in the industry at the conclusion of the war, most of them held subcontracts for engines or parts, much of which the aircraft firms assembled.[70]

Profits in the industry were excessive. The lack of experience in dealings with the industry and important government officials[71] who had close personal connections with the industry were factors which resulted in extremely high corporate profits. For example, the Dayton Wright Company, which was the second largest producer of aircraft during the war, was granted a contract to produce DeHavilland airplanes on a cost-plus basis with a maximum profit of 12 1/2 percent. Because of Government inexperience in these matters or deceit on the part of participating Government officials, or both, the estimated cost per aircraft was set at $7,000, which would allow for $875 profit per plane. As was later discovered, the actual cost of production was $4,400, and, according to the contract, the company was entitled to 25 percent of such savings, which in this case was $650. Total profit per aircraft was therefore around $1,525

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[70]Such companies as Fisher Body (later a part of General Motors), Packard, Ford, and Lincoln were big producers for the industry. (Freudenthal, op. cit., p. 50.)

[71]In a post-war investigation of the aircraft industry by Charles Evans Hughes, it was asserted by Hughes that Colonel Edward A. Deeds took unfair advantages of his key position in aircraft procurement and gave to his friends orders which were of a nature that would virtually guarantee them huge profits. Charles Evans Hughes, Report of Aircraft Inquiry, U.S. Justice Department, 1918, p. 29.

instead of $875.[72] Other examples of fantastic earnings in aircraft production are evident in the automotive industry. Over and above costs it was estimated that Fisher Body would realize $5,500,000; Packard would profit by $8,000,000 on a $5,500,000 investment; Lincoln would net $18,800,000; and Ford would make a profit of $5,375,000 on the production of 5,000 engines.[73] The investigations of the post-war period in effect censured the industry for its lack of responsibility in wartime.

At the time of the Armistice, November 11, 1918, the United States was producing aircraft at the rate of 21,000 planes per year and employment in the industry had risen from 5,000 at the outset of the war to 175,000.[74] Between April, 1917, and November, 1918, 13,894 airplanes were delivered to the Government on contract at a total cost of $113,721,043.39.[75] The aircraft industry itself, exclusive of other wartime producers of aircraft such as the automotive industry, produced an output of 9,742 of these airplanes, and 14,765 of the 41,953 aircraft engines. The total expenditure on all aircraft components was approximately $350,000,000, of which $244,838,162.30, or approximately 70 percent of the total expenditure was for engines.[76] As can be seen from

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[72] Freudenthal, op. cit., p. 45.

[73] Hughes, op. cit., p. 137.

[74] Eaton, op. cit., p. 20. [75] Ibid.

[76] Mingos, op. cit., pp. 46-47, and Eaton, op. cit., p. 20. Whether military aviation and the aircraft industry

the data, the actual aircraft industry produced approximately 70 percent of the aircraft while it produced only about 34 percent of the aircraft engines.

The Post-War Period, 1918-1926

Within three days after the Armistice was signed more than $100,000,000 of aircraft contracts were cancelled.[77] Within three months the industry had contracted to 10 percent of its wartime strength.[78] The few aircraft companies which survived of the twenty-four which existed at the time of the Armistice liquidated surplus plants and cancelled subcontracts; the latter actions forced the automotive industry completely out of the aircraft business.[79] Annual

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of the United States made enough of a contribution to the winning of the war to justify their expense is a subject of some controversy. Freudenthal's position is that Government war expenditures for military aviation of $1,068,637,739 was not justified when the end product of 196 airplanes at the front at the time of the Armistice is considered. (Freudenthal, op. cit., pp. 58-59.) He also points to various statements attesting to the inferiority of American produced aircraft. Mingos, a former official of the industry, has indicated, on the other hand, that the Government did not spend in excess of $1,000,000,000 on military aviation, as had been charged, and that after it is considered what the Government regained through post-war liquidation and sale of surplus supplies, the net cost of wartime aviation was less than $400,000,000. (Mingos, op. cit., p. 44.) Although the evidence makes it appear dubious that our aviation contributed much toward winning the war, there can be little doubt that it would have been a potent factor if the war had been prolonged when it is considered that the United States was producing at an annual rate in excess of 21,000 airplanes when the war was terminated.

[77] Ibid., p. 47. [78] Day, op. cit., p. 17.

[79] Henry Ford got back into the business later on and built about 200 transports between 1926 and 1933. He stopped

production shrank from 14,020 aircraft in 1918, to 780 in 1919, and to an all time post-war low of 263 in 1922.[80] With the drastic cutback in military demand the existing firms were struggling to survive. In the East were the Wright, Curtiss, Loening, Vought, Thomas-Morse, and a few other small firms. In the mid-West were Glenn L. Martin, Dayton Wright, and several much smaller firms. On the West Coast were Boeing, Douglas, and several others of lesser importance. Douglas had started his organization during the slump in 1920. Controversy between the Army and Navy over the airplane versus the battleship produced no firm policy for development of military aviation,[81] leaving a diminished market for the aircraft industry in the years immediately following the war.[82] Whatever civilian demand existed for aircraft was largely provided for by the disposal of surplus military aircraft.

Flying was kept alive by the establishment of various speed and distance records set by Army and Navy pilots and

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making them after one of his favorite young men died in a crash. It is estimated that Ford lost $2,500,000 on his plane manufacturing enterprise. (Frank Cunningham, op. cit., p. 214.)

[80] Civil Aeronautics Administration, op. cit., p. 58.

[81] Mingos, op. cit., p. 66.

[82] As evidence of the difficulties the industry was experiencing, Boeing had switched to producing furniture in the short run in order to stay in business. Curtiss, the nation's largest producer, almost went bankrupt in 1920. (Frank Cunningham, op. cit., pp. 101 and 110.)

ex-service pilots who either flew at their fixed bases or travelled over the country giving exhibitions, performing aerial stunts, and giving passenger rides. The frequent accidents were largely attributable to lack of certification requirements for both aircraft and pilots.

The impact of the "barnstormers" and the record-breakers of the early 1920's was evidently not a significant factor in creating a greater demand for aircraft. Despite the urging of the American Aviation Mission,[83] the National Advisory Committee for Aeronautics, General William Mitchell, and others, little was done by the Government prior to 1926 to help sustain the industry. Commercial aviation was slow to develop. There were very few adequate airports and landing facilities, no weather facilities, and no air laws. The Aeronautical Chamber of Commerce, an organization of manufacturers, operators, dealers, and distributors, was

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[83] In 1919, the Government appointed the American Aviation Mission for the purpose of visiting Europe to study military and commercial aviation to see what use could be made of aviation personnel trained and facilities acquired during the war on which the Government had spent so much. One of the Committee's recommendations was that the Government should either pay private enterprise for flying mail or operate mail lines itself until they became commercially feasible. It was calculated that this would provide a small market for the aircraft industry to assist in helping it survive. In line with the recommendations, in May, 1918, the War Department opened the first air mail route between New York and Washington. Although the immediate impact was insignificant in creating a demand for aircraft, it represented a step in this direction. (Mingos, op. cit., p. 54.)

organized in 1922 to promote commercial aviation. The clamoring of these groups and of General Mitchell, who ultimately was courtsmartialed as an outgrowth of his insistence in presenting the case for air power, moved President Coolidge to appoint Dwight W. Morrow to investigate our air power needs. It was the findings of the officially-sanctioned Morrow Board which led to the passage of several acts which were to assist the industry greatly.

The first of these acts was the Kelly Bill or Air Mail Act.[84] This legislation removed the United States Government from the operation of air mail lines, which it had run since 1918, and turned this task over to private operators. By 1927 the Government's air mail transport was handled by private contract operators.

This act was followed by the passage of the Air Commerce Act of May, 1926, which was by far the biggest step taken towards the development of general aviation thus far. The act charged the Secretary of Commerce with the responsibility of fostering air commerce through the establishment of airports, civil airways, navigational aids, and gave him authorization to provide for registration and certification of aircraft and flying personnel to insure safe operation of aircraft.[85]

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[84]This and other legislative acts referred to below are discussed in greater detail in Chapter Five.

[85]President's Air Policy Commission, Survival in the Air Age (Washington: Government Printing Office, 1948), pp. 155-56.

The industry was given further assurance of an increased demand for its products with the passage of the Navy Five-Year Program in June of 1926, and the Army Five-Year Program in July of the same year. The Army was to build up to 1,600 modern aircraft in the next five years, and was to maintain a force of this many planes thereafter. The Navy was to build up to 1,000 up-to-date aircraft in the same period and was to maintain this strength.

Figure 1 depicts the fantastic contraction of output following the war, the doldrums in the industry throughout much of the period, and the division of the market during the period 1918-1926. The export market remained small throughout the period. Following the passage of the Air Mail Act in 1925, total output increased while output of civil aircraft increased from 16 percent of total output in 1924 to 43 percent in 1925. In 1926, the year of the passage of the Air Commerce Act and the passage of the five-year programs of the Army and the Navy, not only did total production reach a peacetime peak, but also for the first time in history the output of civil aircraft exceeded that of military aircraft. Even though military output had increased over the previous year, the output of civil aircraft had increased proportionately more to 55 percent of the total output. Federal expenditures for aircraft had increased from $6,000,000 in 1922 to $12,000,000 in 1926, and since 1926 they have never been less than this amount.[86]

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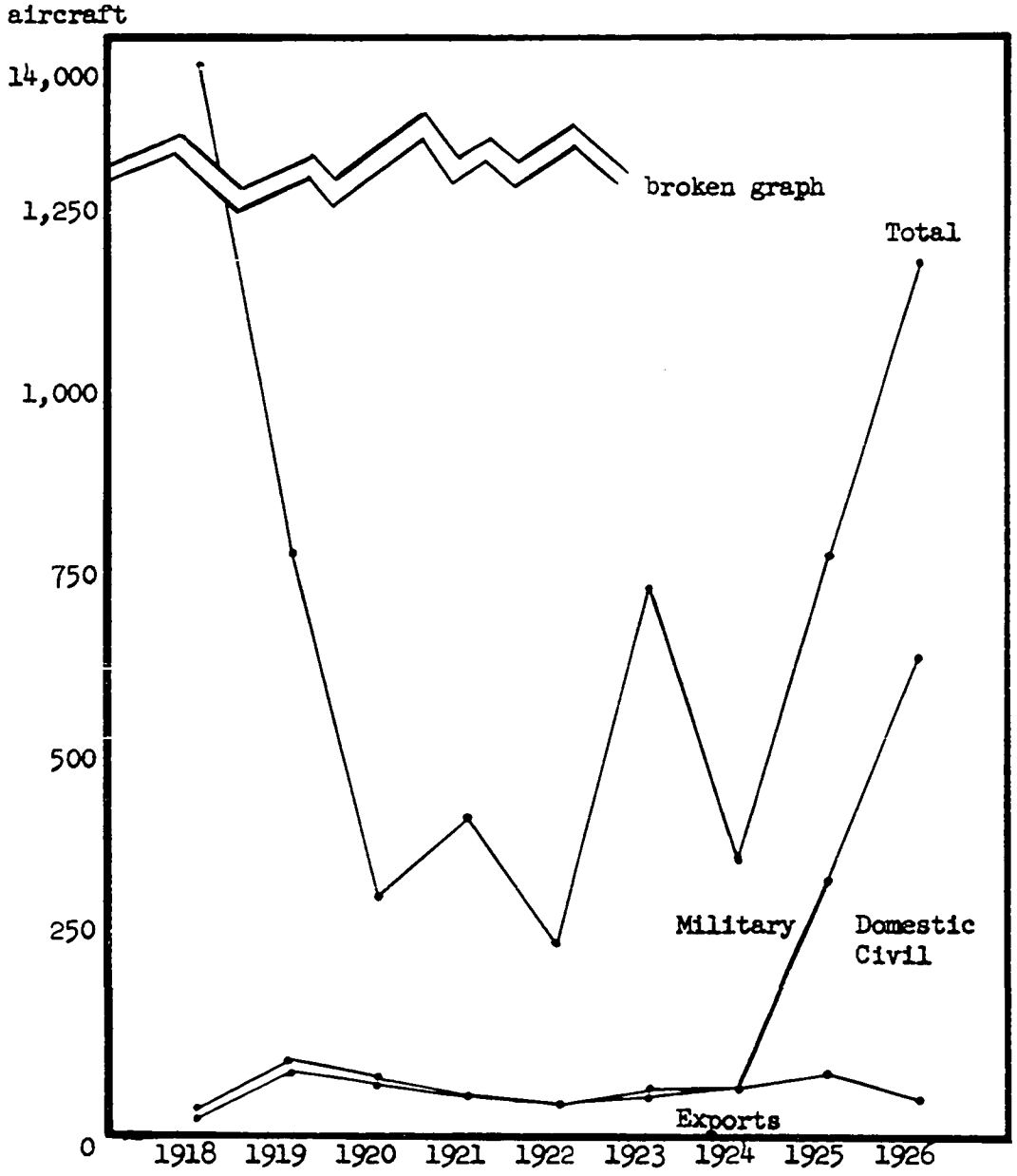
[86]Lee, Aviation Facts and Figures, 1957, p. 24.

FIGURE 1

U.S. AIRCRAFT PRODUCTION, 1918-1926



Source: CAA Statistical Handbook of Civil Aviation, 1957.

The "Lindbergh Boom" and the Great Depression

The year 1927 was a year of history-making flights. Charles A. Lindbergh flew solo non-stop from New York to Paris, France. Lieutenants Lester J. Maitland and Albert F. Hagenberger of the Army Air Corps successfully crossed the Pacific between San Francisco and Honolulu.[87] Clarence D. Chamberlin flew non-stop to Germany, and new altitude and endurance records were established by others.[88] Almost overnight flying had increased significantly in popularity as a consequence of these feats. This, coupled with the Government support provided for in the legislation of 1925 and 1926, led to a notable expansion in the aircraft manufacturing industry. Output increased from 1,186 aircraft in 1926 to 1,995 in 1927 and reached a peak for the period of 6,193 units in 1929. The increase in production was principally in civil aircraft, from 652 units in 1926 to a high of 5,516 units in 1929.[89] The value of aircraft sales had risen from $21,162,000 in 1927 to $71,153,000 in 1929.[90] Although exports increased somewhat, the increase in production and domestic sales of civil aircraft was the outstanding development of the early part of the period.

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[87]Freudenthal, op. cit., p. 90.

[88]Hamlin and Miller, op. cit., p. 394.

[89]Civil Aeronautics Administration, op. cit., p. 58.

[90]Lee, Aviation Facts and Figures, 1957, p. 12.

The expansion of existing firms and the entry of new firms gave the industry an estimated capacity of between 15,000 and 20,000 planes per year by 1929.[91] Table 2 lists 107 of the most important aircraft firms, their locations, and founding dates, when available, which were producing aircraft by 1930. It is interesting to note that of the 88 having known or approximate founding dates, 66 were organized to produce aircraft during the period 1925 to 1929. But the fact that only 6,193 aircraft were produced and only about one half of this output was sold demonstrates that capacity was excessive in terms of current demand. Nevertheless, there were an estimated 296 companies manufacturing planes in the period 1927-1934.[92]

The prospects of increased profits in aircraft manufacturing which led to the expansion by existing firms and the entry of new firms also led to integration and concentration in the industry. Although the interests of the major organizations in the aviation industry were very intertwined, it appears that five more-or-less definite interest groups existed, namely, the Curtiss-Wright Corporation, the Detroit Aircraft Corporation, United Aircraft and Transport Company, the Cord Corporation, and General

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[91] Freudenthal, op. cit., p. 117.

[92] Ibid., p. 118.

TABLE 2

PARTIAL LIST OF AIRFRAME MANUFACTURERS BEFORE 1930

Company	Location	Year of Founding
Acme		1928
Aero-craft	Detroit	1928
Aeromarine-Klemm	New York City	
Alco (Allison Co.)	Lawrence, Kansas	1920
Alexander	Colorado Springs	1925
Alliance	Alliance, Ohio	
American Eagle	Kansas City, Mo.	1925
Arrow	Havelock, Neb.	
Autogiro (Pitcairn)	Bryn Athyn, Penn.	
Bach	Van Nuys, Calif.	1927
Barling (Nicholas-Beazley Co.)	Marshall, Mo.	1921
Bellanca	New Castle, Del.	1927
Berliner-Joyce	Baltimore, Md.	1929
Bird (Brunner and Winkle Corp.)	Long Island, New York	1929
Bird Wing	St. Joseph, Mo.	1927
Boeing	Seattle, Wash.	1916
Buhl	Marysville, Mich.	1925
Burnelli	Keyport, N.J.	1920
Butler	Kansas City, Mo.	1928
Cairns	Naugatuck, Conn.	1928
Capital	Detroit, Mich	1928
Cessna	Wichita, Kansas	1929
Columbia	New York City	(Around 1929)
Command-Aire	Little Rock, Ark.	1928
Consolidated	Buffalo, New York	1923
Courier	Los Angeles, Calif.	1928
Crosley	Cincinnati, Ohio	1929
Cunningham-Hall	Rochester, New York	1928

TABLE 2--Continued

PARTIAL LIST OF AIRFRAME MANUFACTURERS BEFORE 1930

Company	Location	Year of Founding
Curtiss-Caproni	Baltimore, Md.	1929
Curtiss	Buffalo, New York	1907
Curtiss-Robertson	Anglum, Mo.	1928
Davis	Richmond, Ind.	1929
Douglas	Santa Monica, Calif.	1920
Doyle	Baltimore, Md.	1928
Driggs	Lansing, Mich.	1927
Eastman	Detroit, Mich.	
Eberhart	Buffalo, New York	1918
Edo	College Point, L.I.	1925
Elias	Buffalo, New York	1881 (Aircraft since World War I)
Emsco	Downey, Calif.	
Fairchild	Farmingdale, L.I.	1925
Federal	San Bernardino, Calif.	1928
Flamingo (Metal Aircraft Corp.)	Cincinnati, Ohio	1928
Fleet	Buffalo, New York	1929
Fokker	Taterboro, N.J.	1927
G.A.C. (General Airplanes)	Buffalo, New York	1928
Gates	Corona, L.I.	1929
Golden Eagle	Inglewood, Calif.	1929
Great Lakes	Cleveland, Ohio	1928
Hall	Buffalo, New York	1927
Hamilton	Milwaukee, Wisc.	1927
Heath	Chicago, Ill.	
Hunington	Bridgeport, Conn.	1928
International	Cincinnati, Ohio	1928

TABLE 2--Continued

PARTIAL LIST OF AIRFRAME MANUFACTURERS BEFORE 1930

Company	Location	Year of Founding
Invincible	Manitowac, Wisc.	1929
Ireland	Garden City, L.I.	1926
Kari-Keen	Sioux City, Iowa	1928
Keystone	Bristol, Penn.	
Kitty Hawk (Bourdon Corp.)	Wichita, Kansas	(Around 1928)
Dreider-Reisner	Hagerstown, Md.	1923
Kreutzer	Los Angeles, Calif.	
Laird	Chicago, Ill.	
Lincoln-Page	Lincoln, Neb.	1920
Lockheed	Los Angeles, Calif.	1926
Loening	New York City	
Glenn Martin	Santa Ana, Calif.	1909
McCarthy	Portland, Mich.	
Mercury	Hammondsport, New York	1929
Miami	Hieleah, Florida	1929
Mohawk	Minneapolis, Minn.	1927
Mono-Aircraft	Moline, Ill.	1929
Moreland	Los Angeles, Calif.	1928
Moth	New York City	1928
New Standard	Paterson, N.J.	1927
Overcashier	Detroit, Mich.	
Paramount	Saginaw, Mich.	1928
Parks	St. Louis, Ill.	
Pheasant	Fond du Lac, Wisc.	1927
Pitcairn	Bryn Athyn, Penn.	
Richmond	Staten Island, N.Y.	1928
Ryan	St. Louis, Mo.	1922
Savoia-Marchetti (American Aeronautical)	Port Washington, L.I.	1928

TABLE 2--Continued

PARTIAL LIST OF AIRFRAME MANUFACTURERS BEFORE 1930

Company	Location	Year of Founding
Sikorsky	College Point, L.I.	1928
Simplex	Defiance, Ohio	1928
Spartan	Tulsa, Okla.	1928
Stearman	Wichita, Kansas	1927
Stinson	Wayne, Mich.	
St. Louis	St. Louis, Mo.	1928
Stout	Dearborn, Mich.	1922
Sunbeam (Commercial Aircraft)	Pasadena, Calif.	
Swallow	Wichita, Kansas	1919
Szekely	Holland, Mich.	
Temple (Texas Aero)	Dallas, Tex.	1927
Thaden (Pittsburgh Metal)	Pittsburgh, Penn.	1929
Thomas-Morse	Ithaca, New York	1927
Thunderbird	Glendale, Calif.	1927
Timm	Glendale, Calif.	
Towle	Detroit, Mich.	1928
Travel Air	Wichita, Kans.	1925
Trella	Detroit, Mich.	1921
Verville	Detroit, Mich.	
Vought	Long Island, N.Y.	1922
Waco	Troy, Ohio	1921
Wallace	Kansas City, Kans.	1928
Whittlesay	Bridgeport, Conn.	1928
Zenith	Santa Ana, Calif.	1927
The Naval Aircraft Factory	Philadelphia, Penn.	1917

Sources: Sky Master, the Story of Donald Douglas, and A Chronicle of the Aviation Industry, 1903-1947.

Motors.[93]

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[93]Curtiss-Wright Corporation was formed in 1929 to take over Curtiss Aeroplane and Motor Company and the Wright Aeronautical Corporation (formerly the Wright-Martin Aircraft Corporation), the two largest units in the industry. Also it took over the Curtiss-Caproni Corporation, Curtiss-Robertson Airplane Manufacturing Company, Keystone Aircraft Corporation, Moth Aircraft Corporation, Travel Air Company, and Curtiss-Wright Flying Service. (Eaton, op. cit., p. 45.)

Detroit Aircraft Corporation was a holding company set up to gain control over Lockheed Aircraft Corporation, Ryan Aircraft Corporation, Eastman Aircraft Corporation, Blackburn Aircraft Corporation, Aircraft Development Corporation, Winton Aviation Corporation, and Marine Aircraft Corporation. (Ibid., p. 46.)

In 1929 United Aircraft and Transport, formed in 1928, held controlling interest in the following aviation enterprises: Boeing Airplane Company, Chance Vought Corporation, Hamilton Metalplane Company, Sikorsky Aircraft Corporation, Stearman Aircraft Corporation, Northrop Aviation Corporation, Pratt and Whitney Aircraft Corporation, Canadian Pratt and Whitney, Ltd., Boeing Aircraft of Canada, Ltd., Boeing Air Transport, Inc., Boeing School of Aeronautics, United Aircraft Exports, Inc., Pacific Air Transport, and Stout Airlines. (Ibid.)

The Cord Corporation combined the interests of Aviation Corporation, which by itself exercised wide control over numerous firms in the industry, Stinson Airplane Company, Lycoming Foundry and Machine Company, and Airplane Development Corporation. (William Glenn Cunningham, op. cit., p. 41.)

General Motors had extensive holdings in General Aviation Corporation and North American Aviation. General Aviation was the merged Dayton Wright and Anthony Fokker's aircraft firm, while North American was, by 1933, a holding company owning Sperry Corporation, Ford Instrument Company, and Berliner-Joyce Aircraft. North American controlled Curtiss-Wright, owned Douglas stock as well as stock in United Aircraft and Transport. General Motors also had extensive holdings in Bendix Aviation Corporation. Through North American and its subsidiaries it controlled stockholdings in Eastern Air Transport, Western Air Express, Trans-continental and Western Air, Inc., Ludington Air Lines and other companies later a part of Pan American World Airways. (Freudenthal, op. cit., pp. 100-101.)

Figure 2 illustrates further the extent to which the aviation industry was integrated vertically, and horizontally, as of March 1, 1934. Although the integration encompassed other related activities of the aviation industry, the ownership or control of aircraft manufacturing firms along with those of air transport was the most prevalent form of vertical combination. Such combinations were sought to secure financial strength for competition and expansion, and for assured markets for the manufacturers of aircraft. For example, in the early 1930's Boeing was selling its twin engine transport, the 247-D, to its affiliate United Air Lines.[94] P. G. Johnson was the president of both organizations. These combinations obviously had a survival value, for when the industry underwent the violent contraction following the crash of 1929, it was these manufacturing firms which survived while most of the independents went into bankruptcy.

Of the airplane manufacturers, United Aircraft and Transport and the Curtiss-Wright organization, in the period 1927-1933, had the greatest share of sales. Table 3 indicates that during this period their combined share represented

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[94] Frank Cunningham, op. cit., p. 213. Because United Air Lines would be receiving the 247-D, which was superior to other transports then on the market, Transcontinental and Western Air was forced to seek an aircraft which would rival it or run the risk of losing its market share to United. Douglas was awarded the contract for production of its design of the DC-1 to fulfill this purpose.

FIGURE

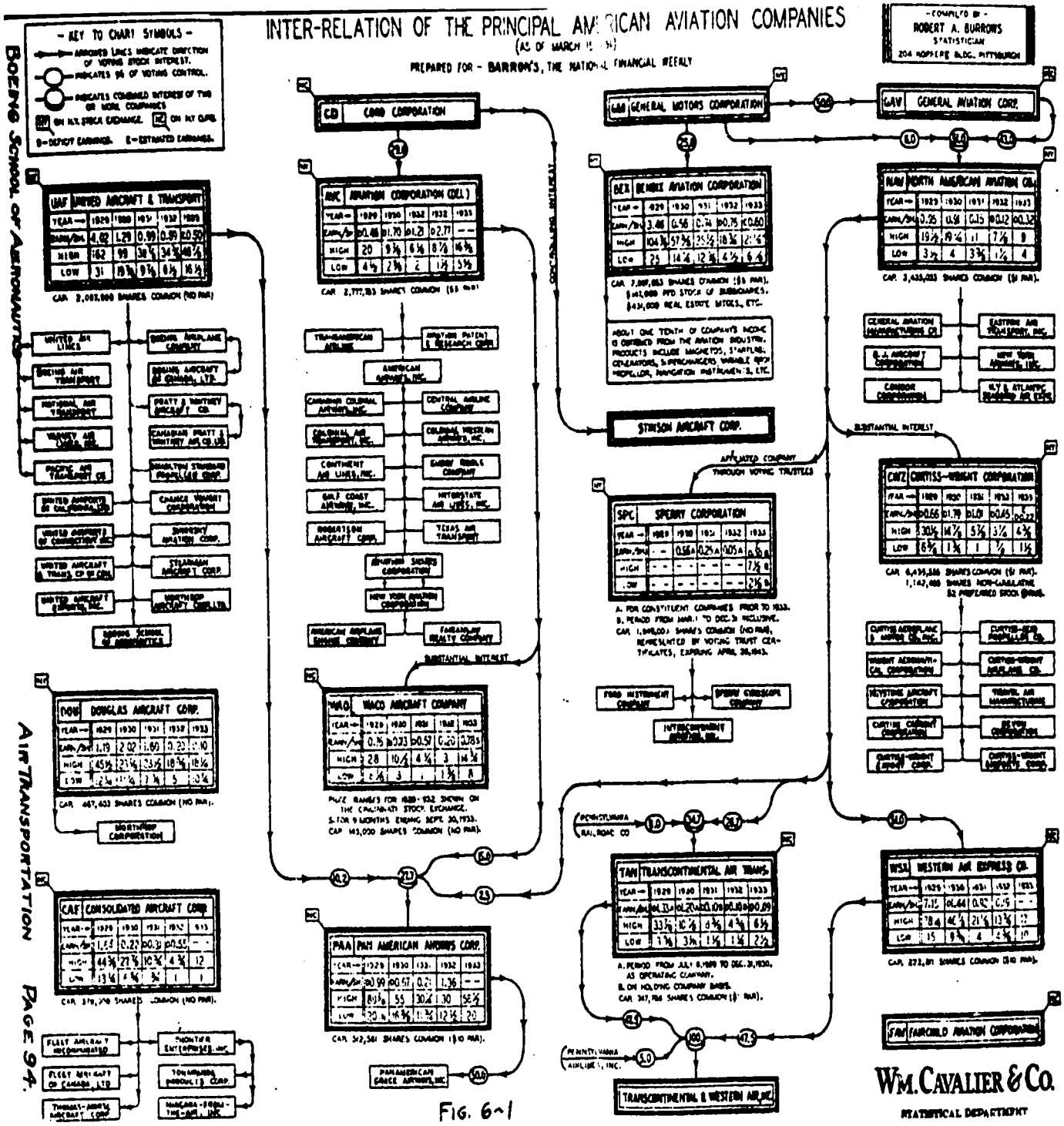

FIG. 6-1

TABLE 3

PLANE AND ENGINE SALES, 1927-1933

Companies	Sales to Navy	Percent of Sales to Navy	Sales to Army	Percent of Total Army Sales	Commercial Sales	Percent of Total Commercial Sales	Total Sales	Percent of Total Sales
U. A. & T. (Boeing, Chance-Vought, Pratt & Whitney)	$33,212,890	48.4	$16,971,553	29.3	$28,056,208	48.0	$78,240,651	42.3
Curtiss-Wright (Curtiss, Wright, Keystone)	15,707,937	22.9	29,047,653	50.2	26,813,517	45.9	71,569,107	38.7
Total	48,920,827	71.3	46,019,206	79.5	54,869,725	93.9	149,809,758	81.0
Douglas	4,551,018	6.7	9,886,605	17.1	1,412,790	2.4	15,850,413	8.6
Glenn Martin	9,895,605	14.4	none	--	none	--	9,895,605	5.4
Great Lakes	2,418,307	3.5	33,686	.1	905,719	1.5	3,357,712	1.8
Consolidated	2,347,622	3.4	1,960,010	3.3	1,118,231	1.9	5,425,863	2.9
Grumman	452,195	.7	none	--	153,492	.3	605,687	.3
Total of Independents	$19,664,747	28.7	$11,880,301	20.5	$ 3,590,232	6.1	$35,135,280	19.0
Total of All Companies	$68,585,574	100.0	$57,899,507	100.0	$58,459,957	100.0	$184,945,038	100.0

Source: The Aviation Business.

81 percent of total aircraft and engine sales, and around 94 percent of total commercial sales of the leading companies which dominated the market. The closest runner-up was Douglas, which had 2.4 percent of commercial sales for this period as opposed to 45.9 percent by Curtiss-Wright and 48 percent by United Aircraft and Transport, and 8.6 percent of total sales as opposed to 38.7 percent by Curtiss-Wright and 42.3 percent by United Aircraft and Transport.

During this period it was these same business combinations which received by far the greatest proportion of Government aircraft orders. As was mentioned previously, there were an estimated 286 firms manufacturing aircraft in the industry; however, military demand was confined to around ten of these firms.[95] Table 3 also depicts the extent of this apportionment of military sales among the leading producers. The combined sales to the Army of Curtiss-Wright and United were about 80 percent of total Army sales, and their combined sales to the Navy were around 70 percent of the total sales to the Navy. These two companies had approximately 75 percent of the military business, which left 25 percent to be divided among the five leading independents and virtually nothing in the way of military sales went to the remaining 279 firms. Further, it has been demonstrated that it was the trustified organizations, of which the leading manufacturers were a part, which were getting by

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[95]Freudenthal, op. cit., p. 118.

far the greatest share of Government air mail payments.[96] In 1933, United Air Lines, an affiliate of the United Aircraft and Transport organization, received 36.45 percent of total Government air mail payments. American Airways, controlled by the Cord Corporation, had 23.67 percent of Government air mail payments. General Motors, through its control over General Aviation Corporation, was benefiting through its affiliated Transcontinental and Western Air, which received 15.94 percent of air mail payments in 1933; Eastern Air Transport, which got 8.93 percent of these payments; and Western Air Express and Pennsylvania Airlines which together received 4.85 percent of this business. This meant that the General Motors interests received 29.72 percent of the total air mail payments of the Government in 1933. The receipt of Government air mail business not only strengthened the positions of the business combinations, but also was an important factor in creating and sustaining a demand for the production of commercial aircraft by the manufacturers within these business combinations.

Although per share earnings dropped after 1929,[97] the profits as a percent of sales of the surviving large manufacturers were high for the entire period under discussion. Boeing made an average of 21 percent on its Navy

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[96]Boeing School of Aeronautics, Air Transportation, Part One (Oakland Airport, California: Boeing School of Aeronautics, 1938), p. 29.

[97]See Figure 2.

contracts and 25 percent on Army contracts; Douglas made 21 percent on its Navy sales and 18 percent on Army sales.[98] Pratt and Whitney, which together with Wright Aeronautical were virtually the only producers of aircraft engines in the period, made profits which were usually in excess of 40 percent per year.[99]

With the general collapse of prosperity in the economy following the stock market crash of 1929, sales of the aircraft industry contracted almost as rapidly as they had expanded during the "Lindbergh Boom." From 1927 to 1929 sales had jumped from $21,162,000 to $71,153,000. By 1933 sales had fallen to $26,460,000[100] and literally scores of companies, especially the smaller new entrants, were forced out of business. Actually, military demand had continued to grow somewhat. It was the decreased demand for aircraft for private and commercial uses which brought on the retrenchment in the industry. At the 1929 peak 5,516 civil aircraft were produced; in 1932, only 803 were produced.

Aircraft exports increased during the period from 63 aircraft valued at $848,568 in 1927 to 406 aircraft in 1933 valued at $5,391,493.[101] However, the value of all

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[98]Freudenthal, op. cit., p. 124.

[99]Ibid., p. 123.

[100]Lee, Aviation Facts and Figures, 1957, p. 62.

[101]Civil Aeronautics Administration, op. cit., p. 65.

aeronautical exports was more than double the value of aircraft exports in 1927 and somewhat less than double the value of aircraft exports in 1933. In 1934, four hundred and ninety aircraft were exported, having a value of $8,195,484 and the value of all aeronautical exports of that year was $17,662,938. Total aircraft produced in the United States by 1934 had risen from the 1933 low of 1,324 to 1,615, of which 1,178 were civil aircraft. The 490 aircraft exported that year constituted a significant amount in relation to the output of civil aircraft. The aircraft exported were considered to be civil aircraft by United States manufacturers, although in most cases during this period they were for purposes of defense or waging war. ". . . Where there were revolutions, wars, or threats of war, there were our aircraft customers."[102]

Although the interlocked positions of the major air transport companies and the large aircraft manufacturers had been suspect for some time, not much action was taken until after February, 1933, when the Crane Committee of the House of Representatives reported that these interests had prevented the free development of aviation and had resulted in the waste of public funds.[103] This disclosure led to

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[102]Freudenthal, op. cit., p. 143.

[103]U.S. Congress, House of Representatives, Committee on Post Offices and Post Roads, House Report 2087, 72d Cong., 2d Sess. (Washington: Government Printing Office, 1933), p. 20.

the passage of the Air Mail Act of 1934. Under this act the air transport companies were forced to be legally separated from the aircraft manufacturers in an effort to prevent the continuance of monopolistic practices which had been in existence since 1928.[104]

An Expanding Market, 1935-1940

Production of aircraft diminished in 1932 and 1933 coincident with a declining civil demand as the depression progressed and with the completion of the Army and Navy five-year programs commenced in 1927. No new Government program was devised until the middle of 1934 when the Baker Board, appointed to investigate the status of American air power, stated that commercial demand was not adequate to maintain the industry.[105] The recommendation of the Baker Board was to increase the number of aircraft of the Army to 2,320 by 1940. That same year the Vinson Act authorized the Navy to buy 1,200 planes by 1940. Table 4 illustrates the impact of the new Government programs as they got well under

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[104] U.S. Statutes at Large, Vol. 48, Part 1 (1933-1934), pp. 933-939. The year 1934 was a bad year in another respect for the leading firms in the aviation industry. In February, all domestic air mail contracts were cancelled and it was announced that the Army was to fly the mail until further notice. Cancellation was ordered because of evidence of fraud and collusion of operators and because contracts had been granted on a non-competitive basis without public advertisement. (Eaton, op. cit., p. 56.)

[105] Special Committee on Army Air Corps, Final Report (Washington: U.S. War Department, July 18, 1934).

TABLE 4

AERONAUTICAL PRODUCTION AND EXPORTS, 1935-1940

Year	Aircraft Production			Aircraft Exported	Percent of Output Exported	Value of Aircraft and Parts Produced	Value of Aeronautical Exports	Percent Exports of Total Value
	Military	Civil	Total					
1935	459	1,251	1,710	333	20%	$45,347,000	$14,291,000	32%
1936	1,141	1,869	3,010	527	18	N.A.	23,143,000	--
1937	949	2,824	3,773	628	17	149,700,000	39,404,000	26
1938	1,800	1,823	3,623	875	24	N.A.	68,228,000	--
1939	2,195	3,661	5,856	1,220	21	279,497,000	117,807,000	42
1940	6,019[a]	6,785	12,804	3,522	28	370,000,000[b]	311,871,000	84

[a]Includes value of output of July through December only.

[b]Represents domestic civil only; data on new aircraft produced for export not available.

N.A. = Not Available.

Sources: CAA Statistical Handbook of Civil Aviation, 1957; Aviation Facts and Figures, 1957.

way in 1936. Production of military aircraft increased from 459 units in 1935 to 1,141 units in 1936. Government expenditures for aircraft almost doubled in 1936 over that of 1935 with an increase from $23,000,000 to $44,000,000.[106]

New authorizations were made in 1938 and 1939 to increase the number of aircraft in the Navy to 3,000 and to 6,000 for the Army as it became increasingly evident that the United States was lagging behind other countries in air power. Military production increased to 1,800 units in 1938 and to 2,195 units the following year.[107]

Such increases in demand did not tax the industry's capacity to produce. Even in 1939 when production was at its highest level in 20 years, the industry was operating only at 75 percent of capacity.[108] But on May 16, 1940, as the necessity for our own national defense became more apparent, President Roosevelt made what at that time appeared to be a fantastic request of the industry:

> I should like to see this nation geared up to the ability to turn out at least 50,000 planes a year. Furthermore, I believe that this nation should plan at this time a program that would provide us with 50,000 military and naval planes.[109]

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[106]Lee, Aviation Facts and Figures, 1957, p. 24.

[107]See Table 4.

[108]Eaton, op. cit., p. 69.

[109]U.S. Congress, House of Representatives, Address of the President of the United States on National Defense, House Miscellaneous Documents, Vol. II, No. 751, May 16, 1940, 76th Cong., 3d Sess. (Washington: Government Printing Office, 1940), p. 3.

By the end of the year capacity was expanding and military production had increased to 6,019 units.[110]

The demand for aircraft exports of the United States increased as international relations deteriorated. The rise in exports following 1935 was due to the domestic difficulties within foreign countries, difficulties between nations, and because Great Britain, France, Germany, and Italy were building their own air defenses instead of exporting aeronautical products to foreign markets to the extent they did previously.[111] This provided a wider export market for American producers of aircraft.[112] Table 5 denotes the ten leading countries purchasing the aircraft exports of the United States over the period 1935-1938. As can be observed from the data, it was the unsettled conditions in Asia and Latin America which accounted for the majority of aircraft exports. By 1939 with the advent of World War II and the extreme need for aircraft by France and Great Britain, the location and amounts purchased by foreign customers changed considerably. Table 6 illustrates the extensiveness of the

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[110]See Table 4.

[111]Freudenthal, op. cit., p. 267.

[112]According to the Neutrality Act (Joint Resolution 67, passed by Congress, August 31, 1935) the United States was not to ship implements of war, and aircraft and aircraft parts were considered such, to any country engaged in war. However, manufacturers were granted licenses to ship aircraft and parts unless there was a declared state of hostilities in the receiving countries.

TABLE 5

FOREIGN MARKETS FOR U.S. AERONAUTICAL EXPORTS, 1935-1938
(Thousands of Dollars)

Country	Value of Aircraft	Value of All Aeronautical Exports	Percent of All Aeronautical Exports
China	$12,406	$20,162	13.8%
Japan	7,174	15,486	10.7
Argentina	9,462	13,263	9.1
Netherlands East Indies	7,259	10,481	7.2
USSR	3,686	9,673	6.7
Netherlands	4,567	9,163	6.3
United Kingdom	2,437	6,567	4.5
Canada	2,412	6,562	4.5
Turkey	4,489	5,820	4.0
Brazil	3,331	5,104	3.5
Totals	$57,223	$102,181	70.3%

Source: U.S. Bureau of Foreign and Domestic Commerce, "Foreign Commerce and Navigation of the United States," The Aviation Business.

TABLE 6

FOREIGN MARKETS FOR U.S. AERONAUTICAL EXPORTS,
January-September, 1939
(Thousands of Dollars)

Country	Value of Aircraft	Value of All Aeronautical Exports	Percent of All Aeronautical Exports
United Kingdom	$18,567	$29,210	37.3
France	11,854	18,969	24.2
Netherlands East Indies	4,664	5,829	7.5
Mexico	2,006	2,974	3.8
Netherlands	1,142	2,810	3.6
USSR	1,959	2,766	3.5
Japan	32	2,324	3.0
Canada	1,394	2,046	2.6
Argentina	400	1,679	2.2
Brazil	1,112	1,493	1.9
Totals	$43,130	$70,100	89.6%

Source: U.S. Bureau of Foreign and Domestic Commerce, "Foreign Commerce and Navigation of the United States," The Aviation Business.

increase in demand for aircraft by France and Great Britain in relation to other leading importing nations. Whereas in the period 1935-1938 the combined value of the French and British imports was less than 6 percent of all United States' aeronautical exports, in the first nine months of 1939 these two countries accounted for 71 percent of the value of total United States' aircraft exports and 61.5 percent of the value of all aeronautical exports. China, the leading purchaser of the earlier period, was no longer among the top ten purchasers and the importance of Japan's purchases had slipped from second to seventh place.

In the short period of five years to 1940, the quantity of our aircraft exports had increased more than 1,000 percent and the value of aeronautical exports had risen by more than twenty-one times that which it was in 1935.

The production of civil aircraft rose significantly during the period from 1,251 units in 1935 to 6,785 in 1940, or by almost four times the 1935 level of production. It should be remembered, however, that aircraft exported were usually considered to be civil aircraft. If exports are deducted from civil output, the results should approximate the civil aircraft produced for domestic sale. The data obtained by this method reveal an increase from 918 airplanes produced in 1935 to 3,263 produced in 1940. The increase in sales of light planes can be attributed to the improvement of general business conditions toward the latter part of

the period, the better flying facilities provided by the Government, and the lower prices of these aircraft.[113] At the same time, commercial airlines were carrying more passengers and flying more revenue passenger seat miles as flying safety improved and air passenger rates decreased.[114] Although air operations increased, the number of aircraft in service declined from 363 in 1935 to a low of 260 in 1938 but increased again to 369 by 1940. This would appear to represent a decrease in sales of commercial aircraft over the period but this was not the case. Actually less aircraft were in service but there was a general conversion toward larger, twin engine aircraft which were more expensive.[115]

During the period the industry underwent a reorganization separating the ownership of companies engaging in the manufacturing and transport fields in accordance with the stipulations of the Air Mail Act of 1934. United

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[113] Aircraft Industries Association of America, Aviation Facts and Figures, 1945 (New York: McGraw-Hill Book Co., 1945), p. 73.

[114] The number of passenger seat miles flown about tripled from 577,700,000 in 1935 to 1,817,100,000 in 1940. Over the same period, passenger rates decreased from an average of $.057 per passenger mile to $.051 per passenger mile. (Aircraft Industries Association, Aviation Facts and Figures, 1957, p. 84.)

[115] Douglas, for example, experienced an increase in sales, largely as a result of the increase in demand for the larger, heavier, transport aircraft such as the DC-1, DC-2, and DC-3. (Frank Cunningham, op. cit., pp. 213, 257.)

Aircraft and Transport Corporation was split into two manufacturing companies. United Aircraft Corporation took over Chance Vought Aircraft, Hamilton Standard Propeller, Sikorsky Aircraft, and Pratt and Whitney Aircraft, all of which were in the East. In the West, Boeing Airplane Company was organized to control the operations of Boeing in Seattle, Boeing Aircraft of Canada, and Stearman Aircraft Division.[116] Curtiss-Wright Corporation was organized into four manufacturing divisions, namely, the Wright Aeronautical Corporation, Curtiss Propeller Division, Curtiss Aero Division, and the St. Louis Airplane Division.[117] The Cord Corporation complied with the Air Mail Act by retaining manufacturing interests in the Aviation Corporation and separating the transport firms from it. After the reorganization, firms within the Aviation Corporation were Stinson Aircraft, Lycoming Aviation Motors, and Vultee Aircraft.[118] With distribution of its stockholdings of various transport companies and the disposal of its interests in other manufacturing concerns, North American Aviation Company was transformed from a holding company to an operating company.[119] This move further lessened the control of General Motors over the industry although its holdings remained large.

On September 11, 1940, the War Department followed

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[116]William Glenn Cunningham, op. cit., p. 49.

[117]Ibid. [118]Ibid., pp. 49-50.

[119]Freudenthal, op. cit., pp. 203-204.

up President Roosevelt's request for 50,000 planes a year by informing aircraft manufacturers to tool up for mass production orders.[120] From a rank of forty-fourth by value of product in 1939,[121] the aircraft industry was soon to become the largest in the country.

World War II, 1941-1945

Almost three months after President Roosevelt's request for 50,000 airplanes, orders had been placed for only 16,000 airplanes. Aircraft firms were hesitant to accept extended production commitments under uncertain cost and profit conditions. It was not until July 2, 1940, that emergency legislation gave the services the authority to grant contracts to manufacturers without going through the lengthy and complex procedure of obtaining competitive bids. Not until the suspension of the Vinson-Trammell Act in October, 1940, was new legislation passed providing for accelerated amortization of defense facilities.[122] With the new legislation providing for freedom for the services to negotiate directly with individual manufacturers on terms which would provide greater certainty concerning the status of cost and profits on contracts, and with the accelerated

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[120] Eaton, op. cit., p. 71.

[121] Ibid., p. 69.

[122] Emergency facilities could be amortized over a five year period for tax purposes. Tom Lilley et al., Problems of Accelerating Aircraft Production During World War II (Boston: Division of Research, Harvard Business School, 1947), p. 27.

tax write-off provisions for expenditures on emergency facilities, the aircraft companies entered into production contracts and began to expand to the extent their resources would allow them.

One method of boosting output of aircraft was to increase the utilization of existing plants. After the Japanese attack on Pearl Harbor, one of the first things accomplished by the Materiel Division of the Air Service was to get all aircraft factories to operate on three shifts, each on a 48 hour week.[123] It was estimated that this would boost output by 30 percent. By early 1945, approximately 60 percent of the direct employees of the airframe companies were working on the first shift, 36 percent on the second shift, and 4 percent on the third shift.[124] The aircraft engine and propeller companies had roughly the same percentage distribution of employees on the three shifts as the airframe producers.[125] In consideration for employing three shifts, the services agreed to pay increased aircraft prices to manufacturers to make up for increased costs coincident with near capacity utilization and overtime pay.[126] As the scale of production increased and assembly line methods were used more extensively, greater specialization and

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[123]Harold B. Hinton, Air Victory: The Men and Machines (New York: Harper & Bros., 1948), p. 191.

[124]Aircraft Industries Association, Aviation Facts and Figures, 1945, p. 23.

[125]Ibid. [126]Hinton, loc. cit.

division of labor were afforded.[127] As a consequence, and with the use of training programs, 80 percent of the working force were able to learn their jobs in six to twelve weeks.[128]

Between June and December of 1940, aircraft companies invested $83,000,000 in new plants and equipment.[129] To insure greater expansion than the private industry could

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[127]Mass production of aircraft by utilization of assembly line production techniques was the big reason why the Government was so anxious to get the automotive industry engaged in aircraft manufacturing. Westley W. Stout, Great Engines and Great Planes (Detroit: Chrysler Corporation, 1947), p. 103. Not only did this new technique of production increase output but it also increased efficiency. With the change in the technology of production from the "job shop" type to assembly line methods, Douglas estimated that the number of handlings for numerous parts and sections was reduced by nearly 50 percent. (Frank Cunningham, op. cit., p. 304.) Productivity increased markedly as assembly line techniques became more widely utilized as the war progressed. In 1941 the average monthly weight output per employee was 28 pounds. By 1944 it had risen to 125 pounds per employee. Reginald M. Cleveland and Frederick P. Graham (eds.), The Aviation Annual of 1945 (Garden City, New York: Doubleday, Doran & Co., 1944), p. 78.

But the conversion was not done without a great deal of difficulty. Ford, for example, when it was licensed to produce the Consolidated B-24, was forced to break the aircraft down into 20,000 drawings to illustrate its assembly before an assembly line could be set up at Willow Run. The difficulty was that aircraft previously were made by highly skilled workmen so that accurate details concerning standard parts, job processes, and manufacturing procedures were not written out so they could be broken down into specialized tasks which could be accomplished by relatively unskilled personnel. Ford had to accomplish this before his assembly line became functional. (Lilley et al., op. cit., p. 49.)

[128]"Mass Production of Skilled Workers," Automotive Industries, 84 (April 1, 1941), 365.

[129]William Glenn Cunningham, op. cit., p. 77.

provide under the existing conditions, the Government announced two methods by which it sought to aid expansion of facilities. The first was known as the "Emergency Plant Facilities" type of contract which provided for initial private financing, or financing by loans from the Reconstruction Finance Corporation, after which the Government would reimburse the manufacturer for his outlay over a five year period and thereby acquire title to the plant. If the company so desired, it could acquire the plant at cost. The second plan provided for the building of plants by the Defense Plant Corporation, a Reconstruction Finance Corporation subsidiary, and the leasing of the plant to the company which could be purchased by the operator if he so desired.[130] Subsequent to October, 1940, as was mentioned above, emergency facilities investment could be written off on a five year basis for tax purposes. The Government did see fit, however, to finance and retain ownership of most of the facilities constructed during the war.[131]

Table 7 depicts the major aircraft companies, the location of their existing facilities prior to the expansion, the location of their new plants after the expansion, and

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[130] Ibid.

[131] In 1957 the Government held two-thirds of the production facilities in the aircraft industry. Considering that the period following World War II was one in which private investment in the industry proceeded at a more rapid rate than Government investment, the proportion of Government owned facilities was even greater at the end of the war. (Lee, Aviation Facts and Figures, 1957, p. 11.)

TABLE 7

POUNDS OF AIRFRAME ACCEPTED, BY PLANTS: 1940-1944
(Thousands of Pounds; Spares Excluded)

Plants	Total	Rank
Major Pre-1940 Plants		
East Coast		
Bell-Buffalo	43,177	17
Chance Vought-Strafford	28,952	22
Curtiss-Buffalo	95,214	7
Grumman-Bethpage	73,767	11
Martin-Baltimore	96,657	5
Republic-Farmingdale	48,834	14
Mid-West		
Curtiss-St. Louis	9,127	30
West Coast		
Boeing-Seattle	166,355	2
Consolidated-Vultee-San Diego	180,702	1
Douglas-Santa Monica	76,041	10
Douglas-El Segundo	24,184	25
Lockheed "B"-Burbank	96,548	6
North American-Inglewood	80,422	9
Total	1,019,980	

TABLE 7--Continued

POUNDS OF AIRFRAME ACCEPTED, BY PLANTS: 1940-1944
(Thousands of Pounds; Spares Excluded)

Plants	Total	Rank
Major New Plants--Aircraft Company Managed		
Near Home Plant, West Coast		
Boeing-Renton	6,686	31
Douglas-Long Beach	123,989	3
Lockheed "A"-Burbank	83,570	8
Remote from Home Plant, Eastern		
Bell-Atlanta	9,860	29
Curtiss-Columbus	27,479	23
Curtiss-Louisville	4,271	33
Republic-Evansville	27,059	24
Remote from Home Plant, Mid-West		
Boeing-Wichita #2	38,913	18
Consolidated-Vultee-Fort Worth	70,027	12
Douglas-Tulsa	29,763	21
Douglas-Chicago	6,277	32
Douglas-Oklahoma City	46,319	15
Martin-Omaha	30,313	20
North American-Kansas City	63,765	13
North American-Dallas "A"	44,315	16
North American-Dallas "B"	22,411	26
Total	635,017	

TABLE 7--Continued

POUNDS OF AIRFRAME ACCEPTED, BY PLANTS: 1940-1944
(Thousands of Pounds; Spares Excluded)

Plants	Total	Rank
Major New Plants--Non-Aircraft Company Managed		
East Coast		
Eastern[b]-Linden	15,836	27
Eastern[b]-Trenton	32,033	19
Mid-West		
Ford-Willow Run	123,076	4
Goodyear-Akron	13,668	28
Total	184,613	
Total Major New Plants	819,630	
Total All Major Plants	1,839,610	
Total All Other Plants	156,003	
Grand Total--All Plants	1,995,613	

[a]The plants are ranked on the basis of the total poundage accepted in the five year period, 1940-1944.

[b]Eastern Aircraft Divisions of General Motors Corporation.

Source: Problems of Accelerating Aircraft Production During World War II.

the pounds of airframe output at both the new plants and old plants for the period 1940-1944. New plant locations accounted for 38 percent of the pounds of airframes accepted. Of course, in the old sites expansion was great also. For example, the Martin plant in Baltimore increased in size from 1,100,000 square feet to 5,650,000 square feet; Boeing in Wichita increased from 157,000 square feet to 2,900,000 square feet. Consolidated in San Diego expanded from 541,000 square feet to 4,510,000 square feet. Almost every airframe plant was expanded to many times its pre-war size.[132]

Besides the expansion carried on by the existing aircraft firms, non-aircraft firms were granted licenses to produce aircraft designed and patented by the aircraft companies. Table 7 depicts the major new plants which were constructed for this purpose for General Motors, which was licensed to produce aircraft for Grumman; for Ford, which produced Consolidated's B-24; and for Goodyear Tire and Rubber Company, which produced the Chance Vought Corsair.[133] Licensing was especially extensive for the production of aircraft engines and other parts, both within and outside the aircraft industry.[134]

But a larger amount of the increased output of air-

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[132]William Glenn Cunningham, op. cit., p. 82.

[133]Lilley et al., op. cit., pp. 90-91.

[134]Ibid., pp. 91-93.

frame weight was accounted for by subcontracting[135] than by licensing. Subcontractors produced about 30 percent of the total pounds of aircraft during the war compared to less than 10 percent produced under license agreements.[136] The expansion of subcontractors of this magnitude is remarkable when it is observed that between 1918 and 1939 airframe subcontracting was hardly existent.[137] With increased profit prospects in numerous types of defense production, in 1941 and 1942 many of the industrial firms, in the Detroit area especially, were hesitant to accept subcontracts. But as material priorities began to affect their own production and cutbacks became necessary, subcontracting in the production of top priority aircraft and parts became the most profitable alternative.[138] Prime contractors generally did not prefer subcontracting to in-plant production largely because of loss of control over costs and quality and difficulties

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[135]Subcontracting is defined as "the procurement of an item or service which is normally capable of economic production in the prime contractor's own facilities and which requires the prime contractor to make specifications available to the supplier." (Day, op. cit., p. 40.)

[136]Lilley et al., op. cit., p. 67.

[137]Day, op. cit., p. 19.

[138]Ibid., p. 30. With the emphasis during the emergency on quality of output and delivery at a specified time, cost of the output was of secondary importance to the Government. Neil E. Harlan, Management Control in Airframe Subcontracting (Boston: Division of Research, Harvard Business School, 1956), p. 240. This coupled with generous cost-plus contracts provided guaranteed returns.

of increased administration,[139] but this was one way to attempt to meet production schedules.[140]

The impetus for output expansion became even greater when, on January 7, 1942, President Roosevelt disclosed to Congress in his State of the Union Message that he had dispatched a directive to appropriate Government agencies informing them to take the necessary steps to increase production to 60,000 planes in 1942, of which 45,000 were to be combat planes; and in 1943 increase production to 125,000 planes, of which 100,000 were to be combat planes.[141] The industry had not begun to fulfill his earlier request for 50,000 planes with a production of only 19,433 military planes in 1941. Nevertheless, the 125,000 mark became an official objective though it was never realized.[142]

Table 8 shows the extent to which plant floor space expanded during the war to provide for the increased output from 13,100,000 square feet in January, 1940, to a peak of

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[139] Lilley et al., op. cit., pp. 67-68.

[140] The following example helps to point out the extreme complexity of administering subcontracting by the prime firms. The 18 foot nose alone of the B-29 had over 50,000 rivets and 8,000 kinds of parts. These parts were produced by over 1,500 major subcontractors! The parts were received and assembled by the prime contractors in four different locations. (Stout, op. cit., pp. 113-14.)

[141] Lilley et al., op. cit., p. 30.

[142] The peak production during the war was in 1944 when 96,433 military aircraft were produced. (Lee, Aviation Facts and Figures, 1957, p. 9.)

175,000,000 square feet in December of 1943. The cost of emergency facilities expansion in the aircraft industry from 1940 to 1945 was $3,894,000,000.[143] Of this sum, $420,000,000 was privately financed and the remaining $3,474,000,000 was financed by the Government.[144] Of the total cost of expansion, $2,338,000,000, or about two-thirds, was for equipment while the remaining $1,556,000,000, or about one-third, was for plant facilities.[145] The Government investment was largely done through the Defense Plant Corporation of which about 80 percent was to produce for the Army Air Forces and the remainder for the Navy Bureau of Aeronautics.[146]

TABLE 8

FLOOR SPACE OF AIRFRAME, ENGINE, AND PROPELLER FACILITIES, 1940-1945

(Millions of Square Feet)

Date	Total	Airframe	Engine	Propeller
Jan. 1940	13.1	9.6	3.0	.5
Jan. 1941	25.5	17.6	6.5	1.1
Jan. 1943	117.1	77.5	31.8	5.2
Dec. 1943	175.0	110.4	54.2	6.8
Dec. 1944	167.4	103.0	54.9	7.9

Source: Aviation Facts and Figures, 1957.

[143] This figure is based on the cost of manufacturing facilities authorized between July, 1940, and June, 1945. Rudolph Mudley and T. S. Cawley (eds.), Aviation Facts and Figures, 1953 (Washington: Lincoln Press, 1953), p. 11.

[144] Ibid. [145] Ibid.

[146] United States Surplus Property Administration, Airplane Plants and Facilities, Report to Congress, January 14, 1946 (Washington: Government Printing Office, 1946), p. 40.

Just as plant expansion had the greatest rate of increase between 1941 and 1943, so was the rate of increase in the output of aircraft the greatest. Table 9 indicates aircraft production increased by 105 percent in 1941 and 82 percent in 1942 over each preceding year. Also coincident with the period of most rapid increase in plant was the increase in pounds of airframe production which underwent a greater percentage increase in 1941 and 1942 than did the production of aircraft reflecting a growing emphasis on the production of medium and heavy transports and bombers. Table 10 portrays a percentage increase in the production of airframe weight of 209 percent in 1941 and 220 percent in 1942 over each preceding year. Although production expanded absolutely through 1944, and actually into 1945, the rate of increase was understandably less after the first two years of the Defense Program.

Between 1941 and the year 1944, when peak production and sales were realized, the aircraft exported and the value of aeronautical exports increased absolutely but declined relatively to total output value as producers expanded output at a greater rate in response to a more rapidly rising domestic military demand. It is interesting to note that as aircraft production rose from the 1941 level to the 1944 peak that the total aeronautical sales rose at a more rapid rate as capacity output was being approached.[147] As many new

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[147]See Figure 3. Output had increased better than 3,300 percent while plant space had expanded slightly under

TABLE 9

RATE OF INCREASE OF AIRCRAFT PRODUCTION, 1941-1945
(Number of Aircraft)

Year	Total	Percentage of Six Year Total	Percentage Increase Over Preceding Year
1940	12,804	4.0%	--
1941	26,277	8.2	105
1942	47,836	15.0	82
1943	85,898	27.0	71
1944	96,318	30.2	12
1945	49,761	15.6	-48
Total	318,894	100.0	

Source: Aviation Facts and Figures, 1957.

TABLE 10

RATE OF INCREASE OF AIRFRAME PRODUCTION, 1940-1945
(Millions of Pounds, Excluding Spares)

Year	Total	Percentage of Six Year Total	Percentage Increase Over Preceding Year
1940	27.8	1.1	--
1941	86.1	3.4	209
1942	275.9	10.8	220
1943	654.7	25.7	137
1944	962.4	37.7	47
1945	542.2	21.3	-44
Total	2,549.1	100.0	

Source: Aviation Facts and Figures, 1957.

aircraft produced during the early states of the expansion began to wear out, the sales of replaceable aircraft parts increased, which accounts for the rising aeronautical sales, of which aircraft spare parts are components, relative to aircraft production.

With only one exception, the top seven of the airframe producers during the war were represented among the top seven during the period 1927-1933.[148] These were the firms, along with several of the smaller producers, which had been carrying on research and had been developing experimental models of aircraft in the period prior to the war. It was natural that these should be the firms which would get the bulk of the military orders in that quantity production of aircraft could be realized sooner by adopting successful existing experimental models and mass producing them.[149]

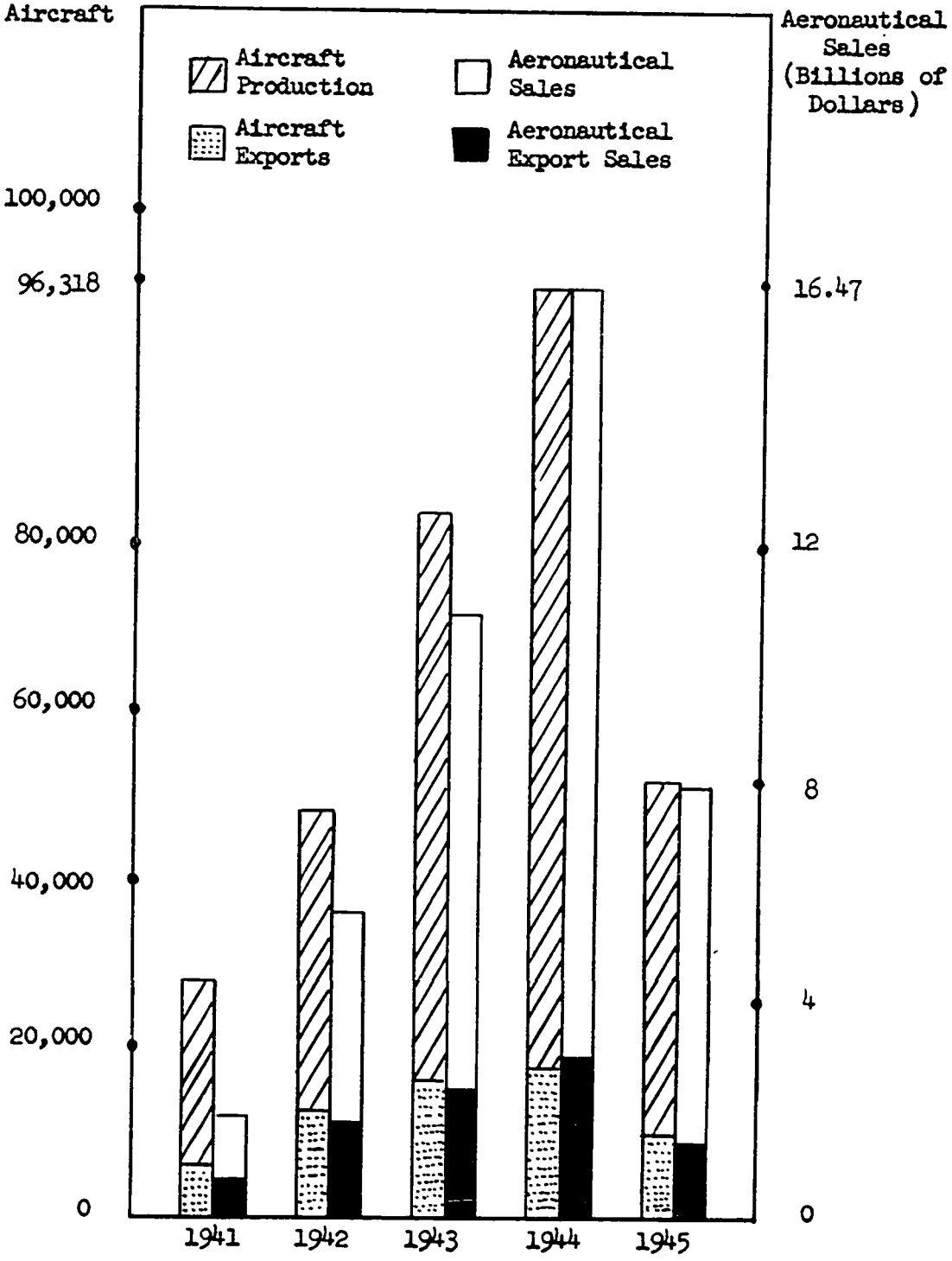
1,200 percent in comparison. The changing technology of large scale production undoubtedly accounted in large measure for the diverging correspondence between quantity of output and plant growth.

[148]Compare Table 3 with Table 11. Lockheed Aircraft Corporation achieved a new position of prominence in the industry by producing nine percent of total airframe output during the period 1940-1944. North American was a holding company during the earlier period, holding stock in the principal producing companies.

[149]This would cut down the lead time between the usual submission of general purpose requirements of an experimental model by the Government and the realization of quantity output because it would eliminate all the stages in the procurement process prior to the award of production contracts. Conservatively, the Government saved between one and two years by adopting for production aircraft which were already in their experimental stages of development. Actually, only two models on which design work was begun after 1940 were used extensively during the war; and of the nineteen major airframe models used during the war, only four of them were in production by mid-1940. This meant

FIGURE 3

U.S. AIRCRAFT PRODUCTION AND AERONAUTICAL SALES, 1941-1945[a]



Source: CAA Statistical Handbook of Civil Aviation, 1957, and Aviation Facts and Figures, 1957.

[a]Total sales data for 1945 are for months January through August only.

TABLE 11

POUNDS OF AIRFRAMES ACCEPTED, 14 COMPANIES ENGAGED PRIMARILY IN PRODUCTION OF MAJOR WAR MODELS OF COMBAT AND LARGE TRANSPORT AIRCRAFT: 1940-1944

(Thousands of Pounds, Spares Excluded)

Company	Total 1940-1944	Percent of Five Year Grand Total
Douglas	306,573	15.3%
Consolidated-Vultee	291,073	14.6
Boeing	226,477	11.3
North American	210,913	10.5
Lockheed	180,118	9.0
Curtiss	136,091	6.9
Martin	126,970	6.3
Ford	123,076	6.2
Republic	75,893	3.9
Grumman	73,767	3.7
Bell	53,037	2.7
Eastern (General Motors)	47,869	2.4
Chance-Vought	28,952	1.4
Goodyear	13,668	0.7
All Other Plants	101,136	5.1
Grand Total, All Plants	1,995,613	100.0

Source: Problems of Accelerating Aircraft Production During World War II.

According to Table 11, fourteen companies produced about 95 percent of the airframe output during the period 1940-1944. Douglas, the largest producer, produced 15.3 percent of the pounds of airframe output. The top seven of the fourteen produced 73.9 percent of the output.

The high marginal efficiency of capital in aircraft production resulting from the increased demand by the Government was followed by almost a 1,200 percent expansion in plant floor space, much of which was Government financed, and a 3,300 percent expansion in aircraft output. In December of 1944, total floor space of prime contractors was 167,391,000 square feet.[150] Peak output of 96,318 aircraft was reached in 1944 and a total of 306,090 aircraft was produced during the period 1941 to 1945, of which 33,000 were lend-leased to the Allies between March 11, 1941, and April 1, 1944.[151] Employment in the industry rose from 148,600 in 1940[152] to a peak of 2,100,000 in November of 1943.[153] From a rank of forty-fourth in value of output

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that seventeen of the nineteen models used extensively during the war were being developed before the entry of the United States into the war. (Lilley et al., op. cit., pp. 16-18.)

[150]Aircraft Industries Association, Aviation Facts and Figures, 1945, p. 2.

[151]Eaton, op. cit., p. 84.

[152]Lee, Aviation Facts and Figures, 1957, p. 56.

[153]Leonard G. Levenson, "Wartime Development of the Aircraft Industry," Monthly Labor Review, November, 1944, p. 915.

in 1939, the United States aircraft industry rose to become the largest manufacturing industry in the world in 1944 with an output value of $16,745,000,000.[154]

Developments of the Post-War Era

Aircraft production facilities expansion had ceased long before the production quotas were realized and before the war was won. There was no notable expansion of production facilities after December of 1943.[155] Airframe facilities were reduced after this time although engine and propeller facilities continued to expand for another year. Production of airframes did not fall, however, until after March of 1944.[156] Propeller production declined after January and engine production after June of the same year.[157] The employment peak of 2,101,600 reached in November, 1943, consequently reduced to 1,464,200 by VE Day, May 8, 1945,

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[154]This sum equals the total value of the combined output in 1939 of the auto industry, steel industry, meat-packing industry, petroleum industry, cigarette companies, bakeries, smelteries of non-ferrous metals, paper mills, and printers and publishers of newspapers, which represented the nine leading United States industries in 1939. (Eaton, op. cit., p. 85.)

[155]Table 8 shows a peak of 175,000,000 square feet in the entire industry in December of 1943. By December of 1944, floor space was reduced by 7,600,000 square feet.

[156]Civil Aeronautics Administration, "Aircraft, Engine, and Propeller Production," U.S. Military Aircraft Acceptances, 1940-1945 (Washington: Division of Aviation Statistics, Office of Aviation Information, 1945), pp. 5, 7-8.

[157]Ibid.

and further to only 519,900 by VJ Day, August 14, 1945.[158] Anticipating the reduction of military demand for aircraft which was to come coincident with peace, the Aeronautical Chamber of Commerce on behalf of the industry presented to the Senate Military Affairs Committee a recommended program to be followed as military demand contracted.[159] The program pointed out that the aircraft industry had a small post-war market awaiting it, and for this reason cutbacks should first affect the temporary wartime manufacturers of aircraft such as the automotive industry which would have substantial post-war markets. The actions of the Government would suggest that it subscribed to the recommendations because the major pre-war airframe, engine, and propeller producers were still making deliveries, although in very reduced amounts, after hostilities ceased. The automotive industry and other licensee firms ceased their aircraft manufacturing operations.[160] The smaller firms which had specialized in production of small liaison and observation planes manufacture such as Aeronca, Bellanca, Cessna, Taylorcraft, etc., were

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[158] William Glenn Cunningham, op. cit., p. 145.

[159] Aeronautical Chamber of Commerce, The Aircraft Industry Prepares for the Future (Washington: Aeronautical Chamber of Commerce, 1944), p. 21.

[160] Ford did not produce airplanes after June of 1945; General Motors (Eastern) stopped in September, and Nash Kelvinator in October. By September of 1945 the Studebaker, Dodge, Ford, Buick, and Chevrolet plants had stopped producing engines. (William Glenn Cunningham, op. cit., p. 148.)

delivering no new aircraft to the Government as early as 1944.[161] By the end of 1945 the Army and the Navy had cancelled 18,267 contracts totalling $21,578,462,000.[162] In general it can be said that the firms making military deliveries in December of 1945 were the major pre-war producers.

The contraction also involved the withdrawal of the non-aircraft companies (the automotive companies for the most part), the dissolution of companies which were organized during the war,[163] and the withdrawal of some pre-war producers.[164] Industry sales had declined from the peak of $6,047,000,000 in 1944 to an estimated $1,200,000,000 in 1947.[165] In December of 1945 there were sixteen airframe plants remaining of the sixty-six which were in the industry one year earlier.[166]

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[161] Civil Aeronautics Administration, "Aircraft, Engine, and Propeller Production," pp. 250-53.

[162] Reginald M. Cleveland (ed.), The Aviation Annual of 1947 (New York: Harper & Bros., 1947), p. 214.

[163] Among these were Globe Aircraft Corporation, American Aviation Corporation, and Columbia Aircraft.

[164] Such were Brewster, Aeronautical Corporation, Culver Aircraft Corporation, Fleetwings, Howard Aircraft Corporation, the Naval Aircraft Factory, and the St. Louis Aircraft Corporation.

[165] Lee, Aviation Facts and Figures, 1957, p. 12.

[166] Day, op. cit., p. 148. Coincident with the contraction were vastly declining profits sharply in contrast with the almost guaranteed profits earned during the war. For example, Boeing, Bell, Consolidated Vultee, Piper, and Lockheed all reported losses for 1947 while Martin, Curtiss-Wright, Douglas, Ryan, and North American were reporting reduced net returns. (Eaton, op. cit., pp. 92-93.)

In its report of October 11, 1945, the Air Coordinating Committee recommended that 3,000 to 5,780 military aircraft would need to be purchased annually, taking into consideration prospective civilian aircraft production, if the industry were to survive sufficiently to provide a safe nucleus from which to expand in national emergency. The estimated output of civil airframe weight and the output of military airframes which was recommended represented from 5 to 9 percent of the 1944 production.[167] Despite these recommendations, the industry received only sufficient orders for delivery of 1,669 military planes in 1946. Table 12 shows the number of aircraft produced and the value of aeronautical production for the military and civil markets for the period 1946-1956. Although in terms of aircraft produced, output for the civil market appeared high in 1946, it was insufficient to offset the extreme cutback in military purchases. Actually, only 38,400,000 pounds[168] of airframe weight were produced that year against a range of 54,300,000 to 104,300,000 pounds recommended by the Air Coordinating Committee.[169]

The continuing low level of sales forced aircraft producers to diversify their output. Such items as aluminum canoes, pie pans, wheelbarrows, dishwashers, furniture, etc.,

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[167]Hinton, op. cit., p. 48.

[168]Lee, Aviation Facts and Figures, 1957, p. 21.

[169]Hinton, loc. cit.

TABLE 12

AERONAUTICAL PRODUCTION AND SALES, 1946-1956

Year	Number of Aircraft			Sales of Aircraft and Parts Produced (Millions of Dollars)			Other Products and Services
	Total	Military	Civil	Total	Military	Civil	
1946	36,670	1,669	35,001	N.A.	N.A.	N.A.	N.A.
1947	17,717	2,100	15,617	$1,200[a]	N.A.	N.A.	N.A.
1948	9,586	2,284	7,302	1,158[b]	$ 884	$ 177	$ 97
1949	6,089	2,544	3,545	1,781	1,438	230	113
1950	6,520[a]	3,000[a]	3,520	2,274	1,836	238	200
1951	7,877[a]	5,400[a]	2,477	3,456	2,525	347	584
1952	12,509[a]	9,000[a]	3,509	6,497	5,004	650	843
1953	15,134[a]	11,000[a]	4,134	8,511	7,026	734	751
1954	12,389[a]	9,000[a]	3,389	8,305	6,649	822	834
1955	12,753[a]	8,000[a]	4,753	8,470	6,445	786	1,239
1956	14,005[a]	6,800[a]	7,205	9,496	6,559	1,166	1,771

[a]Estimate, Aircraft Industries Association.

[b]Sales total for last three quarters only.

N.A. = Not Available.

Source: Aviation Facts and Figures, 1957.

were examples of the type of output in which the industry engaged in its struggle for survival. The appalling condition of the industry in 1947 led to further investigations of the industry by two federal groups, the President's Air Policy Commission and the Congressional Air Policy Board. The crux of their recommendations was that immediate action should be taken to support the aircraft manufacturers.[170] Their reports alerted the public to the collapsed state of the aircraft industry and, therefore, to the growing inferiority of our air defenses. The reports spurred Congress to increase appropriations for aircraft procurement. Military aircraft purchased and sales rose subsequently though civil demand had dropped off significantly from its 1946 level.

The interest in personal plane flying, especially that of former military pilots, stimulated by the war rapidly subsided. Production of light planes dropped off from 34,568 units in 1946 to 7,039 units in 1948 and to only 3,391 in 1950.[171] The post-war boom in the personal plane field was very brief. Owners, when they disposed of the planes, frequently advanced the reason that the cost of owning a personal plane was too high relative to the use gotten out of it.[172]

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[170]See President's Air Policy Commission, op. cit., and Air Coordinating Committee Report (Washington: Government Printing Office, 1947).

[171]Lee, Aviation Facts and Figure, 1957, p. 70.

[172]Lynn L. Bollinger and Arthur H. Tully, Jr., Personal Aircraft Business at Airports (Boston: Division of Research, Harvard Business School, 1947), p. 20.

The number of civil transports produced declined yearly from 433 in 1946 to 160 in 1949,[173] and total civil airframe weight produced declined from 25,500,000 pounds to 6,700,000 pounds over the same period.[174] The post-war demand for new transports was depressed by the sale of surplus military transports. The period prior to 1950 was characterized by declining and generally low levels of output of civil aircraft with a rising output of military aircraft, though not impressive in amount, after 1948.[175] But the recommendations of the Air Coordinating Committee, the President's Air Policy Commission and the Congressional Air Policy Board were soon given a lower priority when in 1950 the Secretary of Defense Louis Johnson started the year with an all out economy drive.[176] Even with the increased appropriations of the preceding two years, most of the firms in the industry were struggling to avoid financial losses.[177]

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[173] Fred Hamlin et al. (eds.), The Aircraft Year Book for 1949 (Washington: Lincoln Press, 1949), p. 69.

[174] Lee, Aviation Facts and Figures, 1957, p. 21.

[175] Notable technological advance was being made in the period. The conventional type fighters and bombers were being replaced with jet aircraft. The year 1949 was an improved one in the industry because of increased Government expenditures in the industry for research and development projects in the development of jet aircraft, atomic energy, rockets, missiles, and supersonic airplanes. (Hamlin et al., Aircraft Year Book, 1949, p. 69.)

[176] Fred Hamlin et al. (eds.), The Aircraft Year Book 1950 (Washington: Lincoln Press, 1950), p. 127.

[177] Three-fourths of all Air Force funds for aircraft procurement went to three companies. J. Carlton Ward, Jr., "Industrial Planning for Production Expansion," Elements of

With the outbreak of the Korean War, the economy drive in the Defense Department was reversed. The necessity of maintaining strong peace-time air defenses and the necessity of peace-time support of the aircraft industry became apparent. As a representative of the Aircraft Industries Association noted:

> The Year 1950 will probably go down in aviation history as the one in which the industry, greatly aided by the Korean crisis, finally won its three-decade campaign for adequate peace-time air defenses.[178]

Between 1949 and the end of 1953, the year the Korean War was terminated, annual output of military aircraft expanded from 2,544 units to an estimated 11,000 units. Civil output did not change appreciably over the period. Annual value of aeronautical production increased sharply from $1,781,000,000 to $8,511,000,000 in the same period. Employment in the industry rose from 281,800 to 779,100 employees.

Because of the existence of World War II plants which were not being utilized, there was little need for construction of new plants. The Air Policy Commission listed

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American Air Power (Washington: Aircraft Industries Association, 1947), p. 24.

The increase in demand following the policy change in 1948 meant increased profits for some firms at least. Convair, which suffered a $7,500,000 loss in the first half of 1948, made a profit of $1,500,000 for the same period in 1949. Boeing, which had a loss of $327,198 in 1947, had a mid-year net of $662,349 in 1949. Ryan's sales doubled in 1949 over 1948, and Douglas's net was $5,000,000 for the period from January to September of 1949 against a loss of $2,000,000 for the same period in the previous year. (Hamlin et al., Aircraft Year Book, 1950, p. 70.)

[178] Ibid.

21,200,000 square feet of available floor space of government plant facilities at the outbreak of the war. Even after the production expansion was more-or-less complete in 1952,[179] around 10,000,000 square feet remained unused.[180] With the existence of surplus floor space which the Government was willing to lease to the aircraft firms, the Government was reluctant to finance new plant expansion. But Government facilities generally were dispersed and geographically removed from locations deemed most desirable to the existing producers of military aircraft. The consequence was that aircraft companies were forced to finance much of their own expansion if they did not choose to use Government surplus plants. Table 13 illustrates the extent to which leading firms financed facilities expansion during World War II and the Korean War. As can be observed, these firms spent larger amounts for plant expansion during the Korean War than they did during World War II. In total, the industry privately financed $805,000,000[181] of aircraft plant facilities from 1950 to 1953 as opposed to $280,000,000 financed by the Government.[182] The Government did, however, finance

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[179]Fred Hamlin et al., The Aircraft Year Book 1952 (Washington: Lincoln Press, 1953), p. 74.

[180]Day, op. cit., p. 105.

[181]Totals of tax amortization certificates for land, buildings, and miscellaneous, processed by the National Production Authority Aircraft Division as of March 1, 1953.

[182]Modley and Cawley, Aviation Facts and Figures, 1953, p. 11.

much of the equipment expansion. The industry financed $399,000,000 of new equipment purchased during the period[183] and the Government financed $2,044,000,000 of the expansion.[184] Therefore, of the total expansion of $3,528,000,000, the Government financed $2,324,000,000, or roughly two-thirds, and the industry financed $1,204,000,000 of the total.

TABLE 13

COMPANY EXPENDITURES FOR AIRFRAME FACILITIES EXPANSION, WORLD WAR II AND THE KOREAN WAR
(Millions of Dollars)

Company	1940-1944[a]	1950-1953[b]
Bell Aircraft Co.	$ 5.8	$ 6.2
Boeing Airplane Co.	10.8	15.3
Consolidated Vultee Aircraft Corp.	27.5	13.0
Douglas Aircraft Co.	15.1	18.1
Fairchild Engine and Airplane Corp.	1.4	6.9
Lockheed Aircraft Corp.	25.1	25.4
Glenn L. Martin Co.	3.9	4.0
McDonnell Aircraft Corp.	--	20.8
North American Aviation, Inc.	5.0	12.9
Republic Aviation Corp.	.6	9.9

[a]Value of facilities authorized.

[b]Value of requests for tax authorization received by the Aircraft Division of National Production Authority as of March, 1953.

Source: Aviation Facts and Figures, 1953.

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[183]Ibid.

[184]Estimate of the Aircraft Industries Association. (Ibid.)

The Government, though unwilling to finance plant expansion when it possessed unused capacity, did facilitate privately financed expansion with the passage of the Defense Production Act of 1950 which allowed for five-year amortization of new facilities for tax purposes and Government guaranteed defense production loans through the Federal Reserve System.[185] Undoubtedly facilities expansion would have been much greater had the Government acceded to the wishes of aircraft manufacturers because manufacturers have demonstrated extreme caution about expanding facilities with their own capital beyond the point where they can be profitably used during the low swings of the procurement cycle. This decision of the Government in effect caused much subcontracting because prime contractors, unwilling to expand facilities privately financed, were being faced with production orders larger than they could handle with existing facilities which they were then utilizing.[186] The limited nature of the aerial warfare relative to World War II did not demand a large output increase so the industry was able to supply the market largely by itself. That which it could not supply it subcontracted. Much of the subcontracting remained within the industry, as did the licensing of which there was considerably less than during World War II.[187]

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[185] Day, op. cit., p. 54. [186] Ibid., pp. 47-49.

[187] For example, though Boeing was "design prime" on the B-47, Lockheed and Douglas were prime contractors in its production also. (Ibid., p. 68.)

Contraction in the industry following cessation of hostilities in Korea in August of 1953 was not as violent as that of World War II.[188] As indicated in Table 12, military aircraft production declined from an estimated 11,000 units in 1953 to an estimated 6,800 units in 1956. Dollar value of military aeronautical production had declined less radically from $7,026,000,000 in 1953 to $6,559,000,000 in 1956. The value of civil aeronautical production had increased from $734,000,000 in 1953 to $1,166,000,000. The annual output of light planes for civil use increased from 3,825 units in 1953 to 6,778 units in 1956 while the average annual output of civil transport aircraft for this time period was 318 aircraft. There was an apparent growing demand for utility type aircraft for use by private business and farmers.[189]

Export demand was also on the increase. From a low of $115,300,000 in 1946 by the end of 1953 the value of aeronautical exports had climbed to $880,600,000 and rose even further to $1,059,300,000 by 1956. This represented an increase from 1.2 percent of the value of total United States merchandise exports to 5.6 percent in 1956.[190]

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[188]Contraction quite naturally was not expected to be as great because expansion was not as great in absolute terms.

[189]Hamlin and Miller, The Aircraft Year Book, 1955, p. 83.

[190]Lee, Aviation Facts and Figures, 1957, p. 105.

Without a doubt the most significant development in the industry since the Korean War has been the manufacturing of guided missiles. Missiles, the most revolutionary technological advance to occur in the industry since jet aircraft, have come into importance since 1951. Figure 4 depicts how expenditures for missile procurement have increased yearly from $21,000,000 in 1951 to an expected $2,955,000,000 by the end of 1958. As of the beginning of 1958, there were 43 announced missile projects and the aircraft industry was the prime contractor for most of them.[191] The technological superiority of missiles as weapons of defense is anticipated to cause an ultimate substitution of them for manned aircraft of combat type. The trend is already obvious. According to Undersecretary of the Air Force Malcolm A. MacIntyre, the Air Force will spend on aircraft in 1961 less than half of the amount it spent in 1956, whereas Air Force spending on missiles is anticipated to be more than five times greater in 1961 than it was in 1956, and will then surpass the annual rate of spending on manned aircraft.[192] With respect to this transition from manned aircraft to missiles, USAF policy states:

> As readily as missiles become operationally suitable, they will be phased into units either to completely

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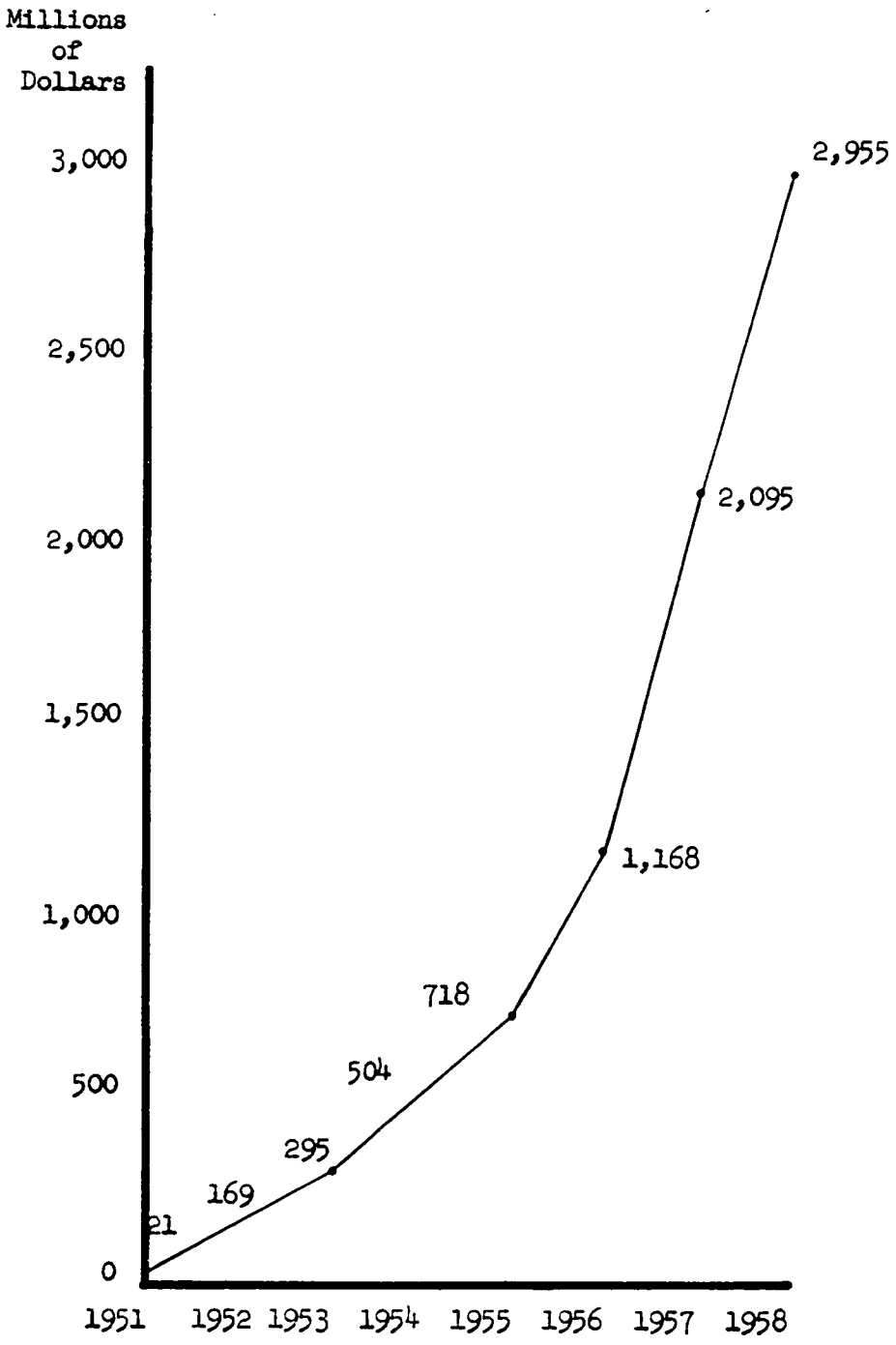
[191] Orval R. Cook, "Air Power Arithmetic," Planes, 13 (Dec. 30, 1957), 3.

[192] Los Angeles Times, April 9, 1958, p. 1.

FIGURE 4

MISSILE PROCUREMENT,
Fiscal Years, 1951-1958



Source: Aviation Facts and Figures, 1958.

or partially substitute for manned aircraft according to military requirements.[193]

Long Run Industry Trends

Technological advance.--To trace the step by step evolution of aircraft to the present is a virtually impossible task considering that there have been over 3,000 different models of airframes developed.[194] The view of Grover Loening, who was associated with the industry almost from the start, is that speed represents the most striking progress made by aircraft in the last 50 years.[195] The rate of increase in speed has progressed on an average at about 24 m.p.h. faster each year.[196] If the past rate of advance continues, by the year 2003 aircraft will be flying at 2,400 m.p.h. Such increases in speed were made possible by improvements in the efficiency of and increases in the horsepower of engines, and airframe design. This desire for speed and the consequent necessity of reducing drag is considered the most important single factor why the shape of the air-

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[193] U.S. Air Force, "The Guided Missile," The Air Reservist, IX (December, 1957), 4.

[194] Basil R. Littin, "Airframe," Encyclopedia Americana, I (1957 ed.), 181d.

[195] Grover Loening, "Fifty Years of Flying Progress, 1955," Smithsonian Institution Annual Report (Washington: Government Printing Office, 1955), p. 210.

[196] Ibid. As of May 16, 1958, the speed record for a manned aircraft was 1,404 m.p.h., which was set by USAF Capt. Walter W. Irwin in a Lockheed 104A jet fighter. (Los Angeles Times, May 16, 1958, p. 1.)

frame has undergone innumerable changes.[197] To move the wind resistant Kitty Hawk plane of the Wrights at 300 m.p.h. would require 46,000 horsepower; by 1960, only 2,300 horsepower will be required to move an aircraft of current design at 300 m.p.h.[198] The increased speeds and loads of aircraft have led to notable changes in materials used in their construction. The Wright plane was made entirely of wood, wire, and cloth--the frame was exposed with only the wing and control surfaces covered.[199] By World War II, fighters and bombers were made entirely of strong, lightweight aluminum alloys and steel.[200]

Up to the 1930's most aircraft constructed were biplanes.[201] Since the early 1930's the monoplane design became more widely adopted. Aircraft power plants were of the line and radial type reciprocating engines until the period 1946-1951 when the transition to jet powered aircraft was being made by the military services.[202] By 1957 the last piston driven fighter aircraft had been retired from

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[197]Littin, op. cit., p. 181b. [198]Ibid., p. 181d.

[199]U.S. Air Force, The History of Military Flight (Washington: U.S. Air Force, 1956), p. 5.

[200]Ibid. Metal was being used increasingly in aircraft construction in the 1930's. The first all metal air transport, the Ford-Stout Pullman, was built as early as 1924. Douglas Rolfe and Alexis Dawydoff, Airplanes of the World from Pusher to Jet, 1490-1954 (New York: Simon & Schuster, 1954), p. 111.

[201]See ibid., pp. 28-160. [202]See ibid., pp. 250-312.

the Air Force and jet bombers had largely replaced those powered by reciprocating engines. Orders for jet and turbo prop jet transports had been made after 1956 by the services and the commercial airlines to replace conventional propeller driven transports.

With the development of superior products production costs and unit prices have increased notably. As examples of this, the World War II fighter, the P-51, cost $50,985.[203] The F-86 fighter produced during the early 1950's cost around $154,000.[204] The B-29 bomber cost $509,465.[205] Its counterpart in 1958, the B-52, at its lowest contract price, cost the Government $3,940,523.[206]

The process of technological innovation in the creation of new and superior products has caused a high rate of product obsolescence in the industry. Just as the all metal airplane proved to be superior to the airplane of wooden construction, the monoplane superior to the biplane, the jet aircraft superior to those with reciprocating engines, so

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[203]Alfred Goldberg (ed.), A History of the United States Air Force, 1907-1957 (New York: D. Van Nostrand Co., 1957), p. 92.

[204]U.S. Congress, House of Representatives, Aircraft Production Costs and Profits, Hearings before the Subcommittee for Special Investigations of the Committee on Armed Services, 84th Cong., 2d Sess., under authority of H.Res. 112 (Washington: Government Printing Office, 1956), p. 1348.

[205]Goldberg, loc. cit.

[206]U.S. Congress, Aircraft Production Costs and Profits, p. 1777.

now the guided missile is demonstrating its superiority to the airplane as a weapon of war.[207] Such "creative destruction" is now forcing the industry to produce technologically superior jet aircraft and missiles.[208]

Sales, output, and employment.--The historical trends in the industry are depicted by Figure 6. It was necessary in each of the three items measured to use two separate graphs to portray these trends because of the fantastic rise in sales, employment, and production in the period beginning with World War II. Prior to 1941 the extent of sales was a matter of millions of dollars and employment a matter of thousands of employees. After that time, measurement of industrial activity was done in billions of dollars and, for a time, millions of employees. Aircraft production per annum, however, has always stayed within the 100,000 range.

As these indices of economic activity in the industry show, there is no discernible secular trend in the industry. Because of the dominance of military aircraft production,

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[207] Although each innovation in this process of historical development of air weapons usually has more than one quality leading to its acceptance over its predecessors, speed appears to be the most sought after characteristic. The superiority of the guided missile lies most in its ability to travel at supersonic speeds. For this reason there has been no known effective means of defense developed against it.

[208] Figure 5 illustrates the evolution of aircraft of the United States Air Force. The illustration classifies the aircraft as to type and, on the reverse side, denotes the manufacturer of each aircraft.

EVOLUTION OF USAF AIRCRAFT

1907 - 1957

All airplanes on the chart are drawn to accurate scale in relation to each other and represent an overall reduction of 720 to 1 from actual size.

All aircraft listed here are represented on the chart. Listing is according to usage, includes manufacturer and is in chronological sequence. To locate given plane on chart, refer to model designation.

TRAINER

TT-1	Martin
JN-2, JN-4D	Curtiss
S-4C	Thomas-Morse
TW-3	Dayton-Wright; Consolidated
PT-1	Consolidated
PT-3	Consolidated
PT-13	Stearman
PT-17	Stearman
PT-19	Fairchild
PT-22	Ryan
BT-1	Douglas
BT-9	North American
BT-13	Vultee
AT-5	Curtiss
AT-6	North American
AT-7	Beech
AT-8	Cessna
AT-9	Curtiss
AT-10	Beech
AT-11	Beech
AT-17	Cessna
T-6G, LT-6G (AT-6)	North American
T-28	North American
T-29	Convair
T-34	Beech
XT-37, T-37A	Cessna
TB-25	North American
TP-51D	North American
TF-102A	Convair

OBSERVATION & LIAISON

Salmson 2A.2	Salmson
DH-4	Various
O-1, O-1G, O-11	Curtiss
O-2H	Douglas
O-19	Thomas-Morse
O-25	Douglas
O-38	Douglas
O-43A	Douglas
O-46A	Douglas
O-47A	North American
YG-1B	Kellett
YIG-51	Ryan
O-49 (L-1)	Stinson
O-52	Curtiss
L-4	Piper
L-5	Vultee
L-13	Convair
L-15	Boeing
L-17	North American
L-17B	Ryan
L-19	Cessna
L-20	DeHavilland
L-23	Beech
L-26	Aero Design

TRANSPORT-CARGO

T-2	Fokker
DH-4B	Boeing
DWC	Douglas
XA-1	Cox-Klemin
C-1	Douglas
C-2, C-7	Fokker
C-4, C-9	Ford
C-8	Fairchild
YIC-12	Detroit
YIC-14, YIC-15	Fokker
YIC-23, YIC-25	Lockheed
C-24	American
C-27	Bellanca
YIC-30	Curtiss
XC-31	Fairchild
C-32, C-33	Douglas
XC-35	Lockheed
C-36	Lockheed
C-40B	Lockheed
UC-43	Beech
UC-45, C-45	Beech
C-46	Curtiss
C-47, C-48, C-49, C-53	Douglas
C-54	Douglas
C-60	Lockheed
UC-64	Noorduyn
C-69	Lockheed
C-74	Douglas
C-76	Curtiss
UC-78	Cessna
C-82	Fairchild
C-87	Convair
C-97	Boeing
XC-98	Boeing
XC-99	Convair
C-118	Douglas
C-119C, C-119G	Fairchild
XC-120	Fairchild
C-121, EC-121C	Lockheed
XC-123, XC-123A (XG-20)	Chase
C-124	Douglas
YC-125B	Northrop
LC-126C	Cessna
MC-131A, C-131B	Convair
C-133	Douglas
KC-135	Boeing

Amphibian

COA-1	Loening
OA-3 (YIC-21)	Douglas
OA-4 (YIC-26)	Douglas
YOA-5	Douglas
OA-9	Grumman
OA-10A (SA-10A)	Vickers
SA-16A	Grumman

Miscellaneous

SB-17G	Boeing
SB-29, KB-29M, KB-29P	Boeing

Helicopter

H-5H	Sikorsky
H-13	Bell
YH-16A	Piasecki
H-19	Sikorsky
H-21	Piasecki

Utility

YU-1	DeHavilland

BOMBER

DH-4	Various
MB-2 (NBS-1)	Curtiss Martin
XNBL-1	Witteman-Lewis (Barling)
B-2	Curtiss
B-3, B-5, B-6	Keystone
YIB-9	Boeing
B-10	Martin
B-12	Martin
XB-15 (XC-105)	Boeing
B-17	Boeing/Douglas/Lockheed
B-18, B-18A	Douglas
XB-19	Douglas
B-24	Convair Ford/Douglas
B-25	North American
B-26	Martin
B-29	Boeing/Bell Martin
B-32	Convair
XB-35	Northrop
B-36	Convair
XB-42	Douglas
XB-43	Douglas
B-45	North American
XB-46	Convair
B-47	Boeing
XB-48	Martin
YB-49, YRB-49A	Northrop
B-50	Boeing
XB-51	Martin
B-52	Boeing
B-57	Martin
XB-58	Convair
B-66	Douglas

ATTACK

GAX (GA-1)	Boeing
A-3	Curtiss
A-8	Curtiss
A-11 (P-30)	Consolidated
A-12	Curtiss
A-17, A-17A	Northrop
A-18	Curtiss
A-20 (P-70)	Douglas
A-24	Douglas
A-26	Douglas
A-36	North American
XA-38	Beech

PURSUIT/FIGHTER

SPAD XIII C.I, SPAD VII C.I	French
Nieuport 28	French
Sopwith Camel	British
S.E. 5A	British
MB-3A	Boeing
SE-5E	Eberhardt
PW-8	Curtiss
PW-9	Boeing
P-1	Curtiss
XP-5	Curtiss
P-6	Curtiss
P-12	Boeing
P-16 (PV-1)	Berliner-Joyce
XP-23	Curtiss
P-26A	Boeing
P-30 (PB-2A)	Consolidated
YFM-1	Bell
P-35	Seversky/Republic
P-36	Curtiss
YP-37	Curtiss
P-38	Lockheed
P-39	Bell
P-40	Curtiss
XP-42	Curtiss
P-43	Republic
P-47	Republic
P-51	North American
XP-55	Curtiss
P-59A	Bell
P-61	Northrop
P-80 (F-80)	Lockheed
XP-81	Convair
P-82	North American
F-84	Republic
XF-85	McDonnell
F-86	North American
F-89	Northrop
XF-91	Republic
XF-92A	Convair
F-94	Lockheed
F-100	North American
F-101	McDonnell
F-104	Lockheed

RACER & RESEARCH

R-6	Curtiss
XPS-1	Dayton-Wright
R3C-1, R3C-2	Curtiss
XS-1 (X-1), X-1E	Bell
X-2	Bell
X-3	Douglas
X-4	Northrop
X-5	Bell

PHOTO/RECONNAISSANCE

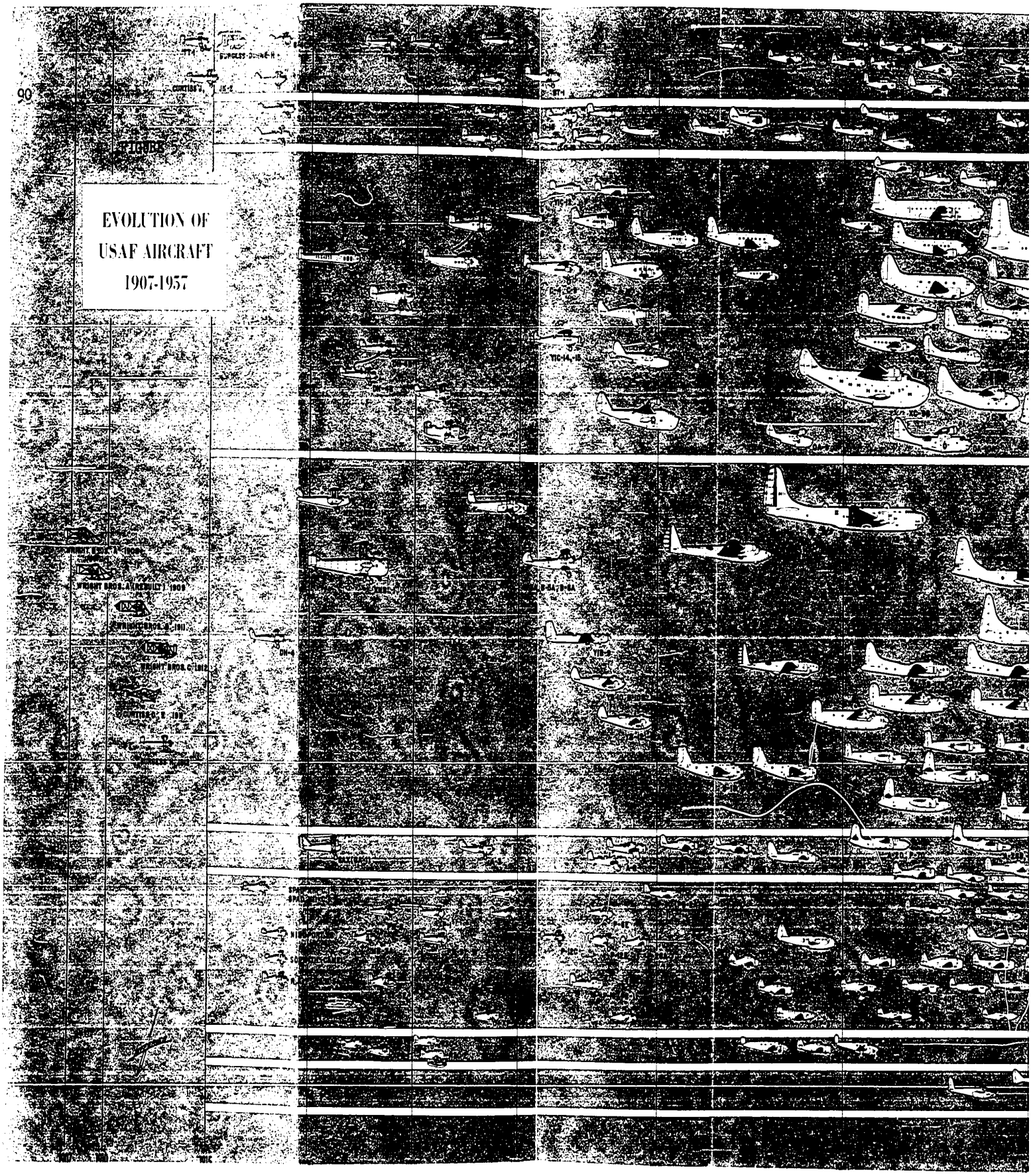
F-8	DeHavilland
XF-11 (XR-11)	Hughes
XF-12 (XR-12)	Republic
XF-15A	Northrop

MISSILE

TM-61	Martin
SM-62	Northrop

FIGURE 5-4

EVOLUTION OF
USAF AIRCRAFT
1907-1957



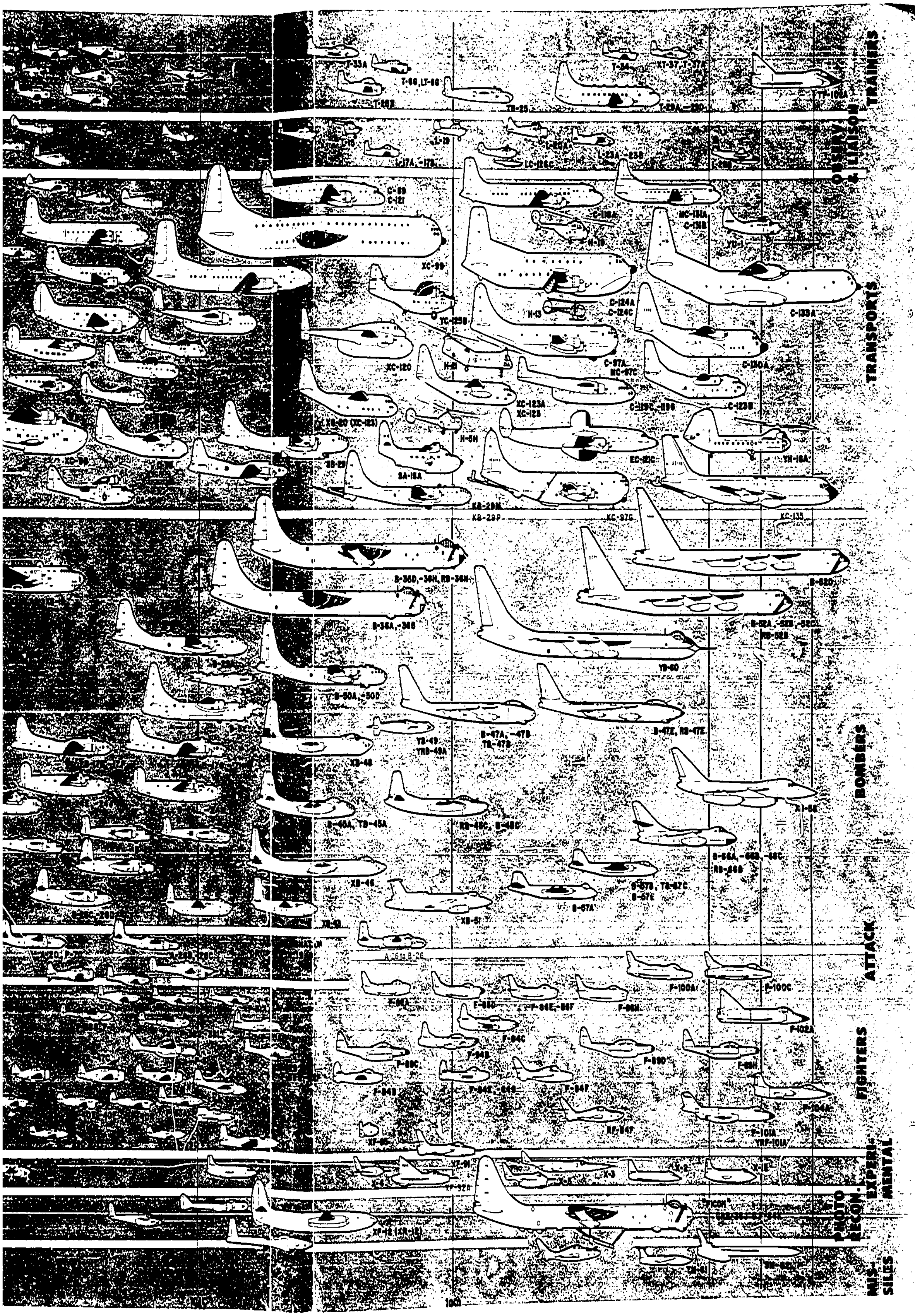
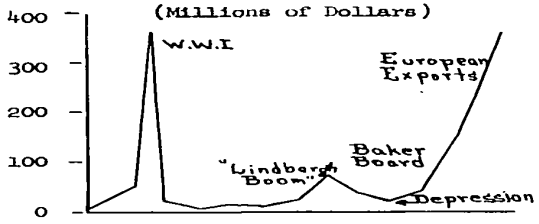
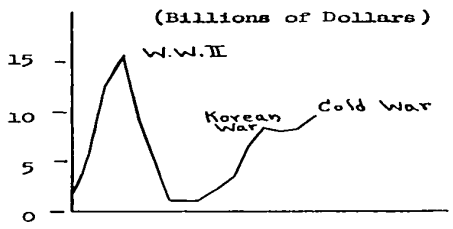

TRAINERS
OBSERV. & LIAISON
TRANSPORTS
BOMBERS
ATTACK
FIGHTERS
EXPERIMENTAL
PHOTO RECON.
MISSILES
T-33A
T-28B
TB-25
T-29A
YT-102A
L-19
L-17A
LC-126C
C-82
C-119
C-124A
C-124C
C-133A
XC-99
H-19
H-13
YC-125B
XC-120
C-97A
C-130A
XC-123A
C-123B
H-5H
SA-16A
EC-121C
YH-16A
KB-29M
KB-29P
KC-97G
KC-135
B-36D, -36H, RB-36H
B-36A, -36B
B-52A, -52B, -52C
RB-52B
B-52D
YB-60
B-50A, -50D
YB-49
YRB-49A
XB-48
B-47A, -47B
TB-47B
B-47E, RB-47E
XB-58
B-45A, TB-45A
RB-45C, B-45C
B-66A, -66B, -66C
RB-66B
XB-46
XB-51
B-57A
B-57B, TB-57C
B-57E
A-26
F-100A
F-100C
F-102A
F-84C
F-89C
F-89D
F-86H
F-84G
F-104A
F-101A
YRF-101A
RF-84F
X-3
X-5
X-15
XF-92A
XF-12 (XR-12)
100

FIGURE 6

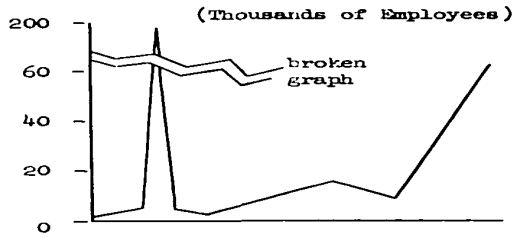
AIRCRAFT INDUSTRY TRENDS, 1914-1956

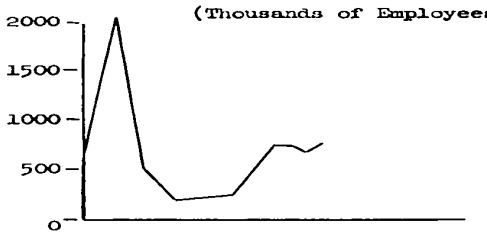
VALUE OF AIRCRAFT AND PARTS PRODUCED



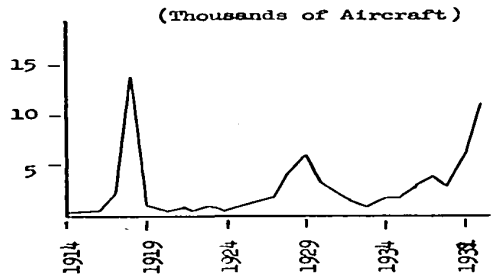


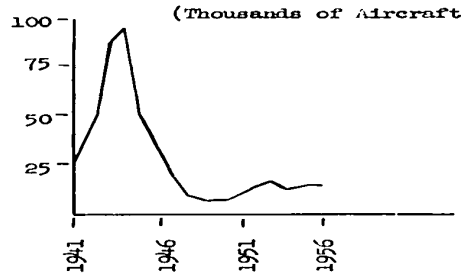
AIRCRAFT EMPLOYMENT





AIRCRAFT PRODUCTION





Source: Aviation Facts and Figures, 1957; Subcontracting Policy in Airframe Industry; Planes, Sept. 1957.

fluctuations in the industry have been attributable almost entirely to fluctuations in military demand.[209] The major changes were, of course, during World War I, World War II, and the Korean conflict, and the level has remained high subsequently due to the intensity of the "Cold War."

Commercial sales.--There are indications that the demand for military aircraft is decreasing as missiles are being substituted for them. But the money demand for civil aircraft, although a relatively small part of the total aircraft market, is increasing. Flying safety has improved rather steadily to the point where in 1955 there was only one fatality per 1,964,459 plane miles flown, compared to one fatality per every 245,845 plane miles flown in 1932.[210] When increasing safety is considered along with the fact that cost of air travel has been decreasing,[211] it seems reasonable to conclude that these have been strong factors

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[209]The discussion of each historical period in the pages above, however, gives a detailed account of all fluctuations in industry sales and output attributable to changing military, civil, and export demand.

[210]Civil Aeronautics Administration, CAA Statistical Handbook of Civil Aviation, 1957, p. 125.

[211]Between 1926 and 1956 the average revenue per passenger mile declined from 12 cents to an estimated 5.30 cents on scheduled airlines. Although railroad coach and intercity bus travel were still much cheaper, 2.56 cents and 2.12 cents respectively, air travel cost had declined much more than either of them in the same period. Pullman rates, often regarded in close competition with air travel, had risen from 3.08 cents in 1937 to 4.77 cents in 1956. (Lee, Aviation Facts and Figures, 1957, p. 99.)

leading to a widening market for air travel and, consequently, for civil aircraft. In 1945 there were 6,576,000 domestic passengers on scheduled airlines at a per mile passenger fare of 4.95 cents. At that time it was estimated that domestic air carriers would have 20,000,000 passengers at an average fare of three cents per mile in 1955.[212] But in 1955 there were 38,025,000 passengers at an average per mile fare of 5.35 cents,[213] which reveals how drastically the rise in demand for commercial air travel has been underestimated. Moreover, the price of passenger air travel had decreased relative to other things. While the consumer price index on all items rose 48 per cent over this same period,[214] the price of passenger air transport had increased only 8 percent.

Since World War II there has been a growing demand for commercial air freight service. Between 1947 and 1957 air freight transport has increased from 38,000,000 ton miles to an estimated 500,000,000 ton miles.[215] The direction in which this market has been growing is evidence of an increase

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[212]Civil Aeronautics Administration, CAA Statistical Handbook of Civil Aviation, 1945 (Washington: Government Printing Office, 1945), p. 38.

[213]Civil Aeronautics Administration, CAA Statistical Handbook of Civil Aviation, 1957, pp. 78, 80.

[214]Board of Governors, Federal Reserve Bulletin, 43 (August, 1957), 970.

[215]Harmar D. Denny, "Wings for Things," Planes, 13 (Nov. 29, 1957), 4.

in demand for commercial transport aircraft for these purposes.

The personal and business plane market has grown markedly in recent years. In 1946 an estimated 1,000,000 hours were flown by business aircraft, as compared to 5,000,000 hours in 1956.[216] Between 1954 and 1956 deliveries of utility type aircraft had increased from 3,073 to over 6,000.[217] Dr. Leslie A. Bryan of the Aircraft Owners and Pilots Association predicts that there will be 80,000 business aircraft in operation by 1966.[218]

Therefore, it appears that as the market for manned aircraft is contracting because of the technological superiority of missiles as weapons of defense, the commercial market for manned aircraft shows signs of expanding because of increasing passenger travel, increased air cargo hauling, and increased use of utility aircraft for business purposes. However, the increase in sales of commercial aircraft will probably be insufficient to offset the decreasing sales of military aircraft in the near future. Only if the aircraft industry can hold on to the missile market can it hope to retain the current high volume of sales.

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[216] Planes, 13 (Oct. 30, 1957), 7.

[217] Roscoe Turner, "Skyway," Planes, 13 (Jan. 23, 1957), 4.

[218] Aircraft Owners and Pilots Association, "Business Flying Looks Like Billion Dollar Business," AOPA Pilot, March, 1956, p. 50a.

CHAPTER II

THE PRODUCT MARKET

The market for the products of the aircraft industry is divided into two principal sectors. The larger of the two by far, both in terms of airframe weight produced and in value of product sales, is the military market sector. In the military market sector the United States Government, for national security purposes, is the sole purchaser of the products of the aircraft industry through its armed services, principally the Air Force, the Navy, and the Army.[1]

The other principal market sector is the civil market, which is further subdivided into the market for transport type aircraft used for commercial transport purposes, and the market for light airplanes used mostly for various business purposes and pleasure.[2]

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[1]Of the three services, the Air Force is the biggest purchaser of the industry's products. Of the projected active aircraft inventory of 41,219 units to be reached at the end of 1958, the Air Force will have 24,398 planes, the Navy 11,790, and the Army 5,031 (Lee, Aviation Facts and Figures, 1957, p. 32). In terms of airframe weight, which also is directly correlated to production cost and product prices, expenditure, and products purchased, the Air Force surpasses the other two services by an even greater margin than indicated by production statistics, which reflect numbers of aircraft purchased.

[2]Those aircraft which are over 3,000 pounds airframe weight are designated as commercial type aircraft. Those

That which follows shows how the recent market for the products of the aircraft industry has been divided among the principal buying groups which purchase the products of the industry for distinct uses.[3]

The Civil Market Sector

The demand for civil aircraft has never been so significant that the industry could have survived except on a very small scale without one or more of the forms of Government assistance which have aided it in its development. Without federal subsidies for air mail transport, federally financed airways facilities and appropriations for airport development, liberal amortization policies in times of expansion, and above all, military contracts for development of aircraft prototypes and for aircraft production, the industry would be one of minor importance. There are countless cases where the development of military aircraft largely financed by the Government have resulted in civil counterparts with small variation in construction.[4] Less obvious

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which fall under 3,000 pounds are considered to be in the personal and business or utility category. U.S. Bureau of the Census, 1954 Census of Manufacturers, Aircraft and Parts, Bulletin MC-37B (Washington: Government Printing Office, 1957), p. 10.

[3]It should be noted that in the industry's market buyers purchase not only the finished products, i.e., aircraft, but also aircraft parts for the maintenance of existing aircraft.

[4]The Boeing C-97 and its civil counterpart, the Stratocruiser, is an example of this. The Boeing KC-135 will have its civil counterpart in the Boeing 707 to be operated in passenger transport by leading airlines.

are the many engineering advances discovered on Government financed projects which have been applied to aircraft manufactured for sale in the civil market. Such indirect Government financing has allowed for lower costs of production and lower prices of improved civil aircraft. Under these circumstances it has been profitable for airlines to purchase aircraft which otherwise they could not have purchased as a profitable undertaking. In short, Government assistance in air transport operations and in aircraft manufacturing has been extremely important in accounting for the existence of the civil market sector for the aircraft industry.

Relative to total aircraft production, total pounds of airframe weight produced, and total sales of the industry, the civil market sector historically has been small in relation to the total market for the products of the industry. Table 14 shows these relationships for the years 1952 to 1956. Civil aircraft output varied annually between 3,489 and 7,205 units and between 27 per cent and 51 per cent of the total 12,389 to 14,005 units produced. Because most of these civil aircraft produced were small relatively inexpensive aircraft, pounds of airframe weight produced and product sales provide a more realistic representation of the importance of the civil market sector in relation to the total market. Civil airframe weight represented between 6.9 per cent and 14.4 per cent of total airframe weight produced. The value of the products of the industry pur-

TABLE 14

RELATION OF CIVIL TO TOTAL AERONAUTICAL PRODUCTION AND SALES, 1952-1957

Year	Aircraft Production			Airframe Weight (Millions of Pounds)			Value of Aircraft and Parts Produced (Millions of Dollars)		
	Total	Civil	Percent Civil of Total	Total	Civil	Percent Civil of Total	Total	Civil	Percent Civil of Total
1952	12,509E	3,509	28%	117.3E	9.3	7.9%	$5,654	650	11.5%
1953	15,134E	4,134	27	151.4E	10.4	6.9	7,700	734	9.5
1954	12,389E	3,389	27	140.5E	10.5	7.5	7,471	822	11.0
1955	12,753E	4,753	37	124.2E	10.2	8.2	7,231	786	10.9
1956	14,005E	7,205	51	111.6E	16.1	14.4	7,725	1,166	15.1

E = Estimate of Aircraft Industries Association.

Source: Aviation Facts and Figures, 1957.

chased by the civil sector of the market ranged between 9.5 per cent and 15.1 per cent of the total for the period. On the basis of the data, the civil market can be said to be a relatively small sector of the total market for the products of the industry.

The commercial market subdivision.--Aircraft purchased for purposes of commercially transporting passengers and cargo, though relatively small in number, make up the biggest proportion of sales to the civil market. The main purchasers of these aircraft are the passenger airlines and air cargo lines. There were 40 United States certified air carriers as of December 31, 1956 operating 1,606 aircraft.[5] Of this number, six were all-cargo lines utilizing 117 aircraft.[6] Eighty-two of the 117 cargo planes were Curtiss C-46's which have not been produced since World War II[7] suggesting that purchases by all-cargo carriers represent a very limited market for the output of new transport aircraft.

Of the airlines purchasing transport aircraft, the "Big Four"--American Airlines, Eastern Air Lines, Trans World Airlines, and United Airlines, operated 692 or 43 per cent of the aircraft used in domestic and international

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[5]Civil Aeronautics Administration, CAA Statistical Handbook of Civil Aviation, 1957, p. 71.

[6]Ibid., pp. 71, 104.

[7]Rolfe and Dawydoff, op. cit., p. 243.

operations in 1956.[8] The purchases of the other 57 per cent were distributed over the remaining 36 operators. As much as 76 per cent of the aircraft in scheduled operation were operated by as few as 12 of the 40 air transport companies.[9]

The export market for civil air transports has been substantial in recent years. Table 16 reveals that as recently as 1955 a total of 95 aircraft of the transport class were exported having a value of $81,200,000 or 39 per cent of civil transport production and sales of that year. In the period 1952 to 1956 export sales of civil transport type aircraft were 34 per cent of the total sales of this category while in number of aircraft produced exports represented 27 per cent of the total.

In relation to total civil production, the output of commercial aircraft ranged in the period 1952 to 1956 between 5.9 per cent and 12.9 per cent of the total, as is depicted in Table 17. However, in terms of value of output,

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[8]There were 1,606 aircraft operated by the United States scheduled air transport industry in 1956. Of this number, 821 were used wholly in domestic operations, 247 were used wholly in international operations, and 518 were used in both domestic and international operations. The balance of the 1,606 was made up of 20 helio copters which were operated domestically. Air Transport Association of America, Air Transport Facts and Figures (18th ed., Washington: 1957), p. 25.

[9]The following companies operated 1,216 of the 1,606 aircraft in operation the latter part of 1956 and early 1957; American airlines, Eastern Air Lines, Trans World Airlines, United Air Lines, Braniff Airways, Capital Airlines, Delta Air Lines, National Airlines, Northeast Airlines, Western Air Lines, and Pan American Airways. See Moody's Investor's Service, Moody's Transportation Manual (New York: D. F. Shea, 1957), and Table 16 for a list of certificated air carriers.

TABLE 15

UNITED STATES CERTIFICATED AIR CARRIERS, BY CLASS
As of December 31, 1956

DOMESTIC TRUNK LINES

Big four

- American Airlines
- Eastern Air Lines
- Trans World Airlines
- United Air Lines

Other trunk lines

- Braniff Airways
- Capital Airlines
- Continental Air Lines
- Delta Air Lines
- National Airlines
- Northeast Airlines
- Northwest Airlines
- Western Air Lines

LOCAL SERVICE LINES

- Allegheny Airlines
- Bonanza Air Lines
- Central Airlines
- Frontier Airlines
- Lake Central Airlines
- Mohawk Airlines
- North Central Airlines
- Ozark Air Lines
- Piedmont Aviation
- Southern Airways
- Southwest Airways
- Trans-Texas Airways
- West Coast Airlines

HELICOPTER LINES

- Chicago Helicopter Air Service
- Los Angeles Airways
- New York Airways

TERRITORIAL LINES
(Other than Alaska)

- Hawaiian Airlines
- Trans-Pacific Airlines

INTERNATIONAL AND OVERSEAS LINES

- American Airlines
- Braniff Airways
- Caribbean Atlantic Airlines
- Delta Air Lines
- Eastern Air Lines
- Mackey Airlines
- National Airlines
- Northwest Airlines
- Pan American World Airways
- Pan American-Grace Airways
- Trans World Airways
- United Air Lines
- Uraba, Medellin, and Central Airways

ALL-CARGO LINES

- AAXICO Airlines
- Aerovias Sud Americana
- Flying Tiger Line
- Riddle Airlines
- Seaboard and Western Airlines
- Slick Airways

Source: CAA Statistical Handbook of Civil Aviation, 1957.

TABLE 16

EXPORTS OF NEW CIVIL AIRCRAFT, 1952-1957

Year	Number of Aircraft			Value of Aircraft (Millions of Dollars)		
	Total	Over 3,000 lbs. Class	Under 3,000 lbs. Class	Total	Over 3,000 lbs. Class	Under 3,000 lbs. Class
1952	840	25	815	$23.8	$18.2	$5.6
1953	863	87	776	84.6	79.2	5.4
1954	639	110	529	97.5	93.0	4.5
1955	844	95	749	88.6	81.2	7.4
1956	1,117	151	966	143.9	132.9	11.0

Source: Aviation Facts and Figures, 1957.

TABLE 17

RELATION OF COMMERCIAL TRANSPORT PRODUCTION TO TOTAL CIVIL AIRCRAFT PRODUCTION, 1952-1957

Year	Total	Commercial Transports	Percent Commercial Transports or Total	Value of Production (Thousands of Dollars)		
				Total	Commercial Transports	Percent Commercial of Total
1952	3,509	452	12.9%	$197,151	$173,299	88%
1953	4,134	309	7.5	244,418	211,030	86
1954	3,389	291	8.6	295,738	254,502	86
1955	4,753	245	5.2	271,250	208,138	77
1956	7,205	427	5.9	454,156	355,792	78
1957	N.A.	537	N.A.	680,744	586,381	86

Source: Bureau of the Census, Facts for Industries Series.

the commercial transport production averaged well over 80 per cent of the total civil market for the period. The big growth of value of total civil production from $197,151,000 in 1952 to $680,744,000 in 1957 is largely attributable to the increase in value of commercial transport sales from $173,299,000 in 1952 to $586,381,000 in 1957.

The extent of the market for civil transports is increasing. Route mileage has increased from 120,400 miles in 1946 to 198,528 in 1956. In 1956, the airlines carried their 300,000,000th passenger.[10] Whereas it had taken 24 years to carry the first 100,000,000 passengers, and four more years to carry the second 100,000,000, it took only a little over two more years to carry the next 100,000,000.[11] Table 14 indicated almost a 70 per cent increase in civil airframe weight since 1952 much of which represented transport aircraft output; and Table 17 indicated that sales of transport aircraft had increased over 300 per cent for the same period. In 1956 the air transport industry had committed itself to $2,600,000,000 in orders for piston-engined aircraft and jet aircraft. By the end of 1956 the backlog of new aircraft on order was 670.[12]

The increase in demand for air passenger services noted above, and cargo hauling, has been followed by a

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[10] Air Transport Association of America, op. cit., p. 5.

[11] Ibid.

[12] Ibid.

rather steady rise in profits in the total scheduled airline industry from a net loss of $26,404,000 in 1947 to a net accounting profit of $78,780,000 in 1956.[13] Rising profits have consequently caused air carriers to expand facilities resulting in the increased demand for the products of the aircraft manufacturing industry.

As would be supposed, the demand for commercial transport aircraft is a derived demand from the demand for civil air transport services. For example, total revenue ton miles flown increased from 692,739,000 in 1947 to 1,903,180,000 revenue ton miles in 1954.[14] Between the same two years commercial aircraft sales increased from $122,073,000 to $254,502,000.[15] In other words, revenue ton miles flown increased approximately 275 per cent. Commercial transport sales increased approximately 209 per cent. Although it increased at a somewhat slower rate, commercial transport sales increased correspondingly as revenue ton miles increased.

Market classification.--Producers of transport aircraft sell in a market in which a small number of buyers purchase most of the civil transport aircraft produced. In the civil transport market subdivision buyers buy directly

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[13] Ibid., p. 20.

[14] Civil Aeronautics Administration, CAA Statistical Handbook of Civil Aviation, 1957, p. 85.

[15] U.S. Bureau of the Census, 1954 Census of Manufacturers, loc. cit.

from manufacturers.[16] Because of their limited numbers and the very large dollar outlay which they would make for each aircraft purchased,[17] they are in positions to exercise more bargaining power over sellers than if they were numerous and if individual purchases were small in dollar value. The demand side of the market therefore is essentially oligopsonistic in structure.[18]

Personal and business aircraft market.--Aircraft purchased for general purposes, greatly outnumber aircraft purchased for commercial transport purposes. During 1956, there were 63,000 aircraft in this category which flew 10,000,000 hours in contrast to the nation's transport

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[16] J. G. Glover, W. B. C. Collins, and G. Rowland (eds.), The Development of American Industries, 3rd. ed. (New York: Prentice-Hall, 1951), p. 850.

[17] In 1946 four engined airliners cost around $625,000. Much improved versions cost around $2,000,000 in 1956. The new jet liners of Boeing and Douglas will cost up to $6,250,000. (Air Transport Association of America, op. cit., p. 9.)

[18] The classification is made on the basis that buyers are small in number, or few, which is in accordance with the definition of "oligopsony" in the standard works on the subject of price theory. The fact that there are at least 40 potential buyers of commercial transport aircraft in this country alone might cause some to consider the classification in this instance erroneous. However, when we consider the predominance of 12 of the 40 commercial operators the classification appears correct. Further, according to Professor William Fellner: "The number of such important sellers or buyers must be small--they must be few--in a sense defined in relation to the term 'important'; individual members of a very large group are not important in this sense. Such important sellers and buyers are called oligopolists or oligopsonists. They may or may not coexist with an atomistic group of sellers or buyers in the same industry." William Fellner, Competition Among the Few (New York: Alfred A. Knopf, 1949), p. 17.

fleet which operated less than 1,500 aircraft and flew 3,500,000 hours.[19]

Light aircraft of this classification are purchased for a variety of uses. Businesses own and use them as a means of rapid transportation in connection with business operations. In fact, an estimated 45 per cent of the total hours flown by light civil aircraft in 1955 was for business purposes.[20] They are also used for such commercial purposes as aerial surveying and mapping, patroling of power lines and pipe lines, supply hauling to remote areas, and other miscellaneous uses. In agriculture such aircraft are used for crop dusting, spraying, seeding, fertilizing, fence patroling, etc., as well as for transportation. Such industrial and agricultural uses accounted for around 20 per cent of the hours flown by this class of aircraft in 1955. In the same year the use of aircraft for instructional purposes amounted to about 13 per cent of total hours flown by light civil aircraft. Contrary to popular belief, the use of such aircraft for pleasure or sport is small in relation to total hours flown by them. In 1955 flying for sport and pleasure represented only 21 per cent of total hours flown.[21]

In the period 1952 to 1956 annual shipments of per-

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[19]Lee, Aviation Facts and Figures, 1957, p. 67.

[20]Ibid., p. 73.

[21]Civil Aeronautics Administration, CAA Statistical Handbook of Civil Aviation, 1957, p. 43.

sonal type aircraft ranged from a low of 3,057 units in 1952 to a high of 6,778 units in 1956.[22] Utility, or personal type, aircraft averaged more than 90 per cent of total civil aircraft shipments for the period. But in terms of the value of all civil shipments, they averaged less than 20 per cent of the total.

As noted in Table 15, the export market for utility aircraft has ranged numerically between 529 units and 966 units, and in value terms between $4,500,000 and $11,000,000. Exports as a per cent of output of utility aircraft has varied between 14 per cent in 1956 and 26 per cent in 1954 although exports of 966 units in 1956 was, in absolute terms, the high for the period. The value of exports for the period ranged between 11 per cent of total output in 1954 and 24 per cent in 1952, and in absolute terms reached the high of $132,900,000 in 1956. The export market for utility aircraft is a significant part of the total utility aircraft market.

Market classification.--Light plane producers sell in a market where buyers number in the thousands. Actually they sell through distributors or factory appointed dealers.[23] Because of their number and lack of organization, individual buyers are not in a position to exercise significant power over sellers to influence price. The demand side of the

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[22]See Table 18, infra.

[23]Glover, et al., op. cit., p. 850.

TABLE 18

RELATION OF UTILITY TO TOTAL CIVIL AIRCRAFT PRODUCTION, 1952-1957

Year	Production			Value of Civil Production (Thousands of Dollars)		
	Total	Utility	Percent Utility of Total	Total	Utility	Percent Utility of Total
1952	3,509	3,057	87%	197,151	23,852	12%
1953	4,134	3,825	92	244,418	33,388	14
1954	3,389	3,098	91	295,738	41,402	14
1955	4,820	4,575	95	271,250	63,112	23
1956	7,205	6,778	94	454,156	98,364	22
1957	6,656	6,119	89	680,744	94,363	14

Source: Aviation Facts and Figures, 1958; Bureau of the Census, 1954 Census of Manufactures.

market for light aircraft therefore is "competitive" in structure.

The Military Market Sector

Although the annual output of civil aircraft has frequently been greater than that of military aircraft since 1909, expenditures for civil aircraft have been small historically in comparison to expenditures for military aircraft. It was observed in the previous chapter that the demand for military aircraft changed in response to changes in defense policy as our requirements for national security were altered. The purchases of aircraft for military uses are made by one buyer, the United States Government. However, buying is done through and for the independent services, the Air Force, the Army, the Navy, and to a lesser extent, the Marines and the Coast Guard. Each service has assigned military missions to perform in assuring national security. To execute these missions it has what are termed organized "weapons systems." For example, the Air Force has four weapons systems: the strategic air system, the air defense system, tactical air system, and the air transport system.[24] Each of these systems in turn requires certain types of equipment, in this example, aircraft, which will assist it in accomplishing its task relative to the over all mission of the Air Force. In 1956, the Air

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[24]D. L. Putt, "Systems Approach to Air Weapons Development," Society of Automotive Engineers, 61 (February, 1953), 60.

Force was purchasing four different bomber types, one tanker type, four trainer types, seven fighter types, three cargo types, two transport types, one utility type, and one anti-submarine type aircraft.[25] The Army was purchasing two types of liaison aircraft and the Navy was purchasing four trainer types, seven fighter types, two attack types, two anti-submarine types, two utility types, and one minelayer type aircraft.[26] Each aircraft type purchased was designed to perform a particular function in the operation of a weapons system.

The extent to which the military market sector represents the largest proportion of the total aircraft market is revealed in Table 19. Between 1952 and 1956 total aircraft production has fluctuated between an estimated 12,389 units and an estimated 15,134 units. Military production has ranged between an estimated 6,800 units and 11,000 units. During three of these years, even in terms of numbers of aircraft produced, military production was over 70 per cent of total aircraft output. But production units are a less meaningful indicator of the importance of the military market sector relative to the total market because total unit production data includes a large number of small, relatively inexpensive civil aircraft. Airframe weight and value of aircraft and parts produced are there-

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[25] Lee, Aviation Facts and Figures, 1957, p. 17.

[26] Ibid.

TABLE 19

RELATION OF MILITARY TO TOTAL AERONAUTICAL PRODUCTION AND SALES, 1952-1957

Year	Aircraft Production			Airframe Weight (Millions of Pounds; Excluding Spares)			Value of Aircraft and Parts Produced (Millions of Dollars)		
	Total	Military	Percent Military of Total	Total	Military	Percent Military of Total	Total	Military	Percent Military of Total
1952	12,509E	9,000E	72%	117.3E	108.0E	92%	5,654	5,004	88%
1953	15,134E	11,000E	73	151.4E	141.0E	93	7,760	7,026	90
1954	12,389E	9,000E	73	140.5E	130.0E	92	7,471	7,026	89
1955	12,753E	8,000E	63	124.2E	114.0E	92	7,231	6,445	89
1956	14,005E	6,800E	49	111.6E	95.5E	86	7,725	6,559	85

E = Estimate of Aircraft Industries Association.

Source: Aviation Facts and Figures, 1957.

fore better indicators of the importance of the military market sector relative to the total market. Between 1952 and 1956 military airframe weight represented over 90 per cent of total airframe weight produced for four out of the five years. In terms of value of aircraft and parts produced, military output ranged between 85 and 90 per cent of the total in the same time period. This data reveals the predominating importance of the military market sector relative to the total market for the products of the industry.

It was noted in the previous chapter that the aircraft industry is presently in a state of radical transition. Technological innovation in weapons development of rockets and missiles is accelerating the obsolescence of manned fighters and bombers. In an address delivered in 1949, John K. Northrop, a pioneer and leader in the aircraft industry, stated with great foresight that pilotless guided missiles would form the backbone of the Air Force's offense by 1960.[27] He further predicted that manned military aircraft would be limited to transports of various sizes and categories.[28] By mid-1957 missile development was far enough along that it was anticipated that the development of new manned bombers was about to end. General Ira Baker, Director of Procurement and Production of the

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[27]Northrop, op. cit., pp. 23-24.

[28]Ibid., p. 25.

Air Material Command of the Air Force, speculated that:

> ". . . one or two more maybe, but not much more" new bombers would be developed, and the extent of this development. ". . . depends on the ICBM."[29]

General Baker expressed the belief that a major missile break-through would virtually obviate the development of new long range bombers. In October, 1957, it became obvious that the Soviet Union possessed an intercontinental ballistic missile when it launched a heavy earth satellite. By the end of December, 1957 the United States had revealed its possession of intercontinental missiles when President Eisenhower stated in a television broadcast:

> A different kind of missile, the air-breathing Snark, recently travelled over a guided course for 5,000 miles and was accurately placed on target.[30]

Though the Air Force will undoubtedly continue to buy current production models of manned bombers and some new models presently being designed until its arsenal of ICBMs is adequate, the granting of new design and production contracts for bombers is somewhat dubious.[31] There is little reason to doubt that the already operational shorter range missiles of several types will cause a similar fate as in bombers for fighter aircraft, fighter-bombers, and

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[29]Merrill Lynch, et al., "The Course of Air Material Command," Investors Reader (July 24, 1957), pp. 4-5.

[30]U.S. Air Force, "The Guided Missile," p. 5.

[31]For example, North American presently has the development contract for the B-70 supersonic bomber. Undoubtedly production contracts for it will eventually be awarded but it is believed that the B-70 is one of the last bombers which will be designed and produced.

interceptors.

The airframe industry also sells products and services other than aircraft. The "other products" category ranged between a low of $751,000,000 and a high of $1,771,000,000 of sales between 1952 and 1956.[32] Such sales include various projects performed for the Government in the development of prototypes, research, and missiles sales--the latter of which is the most important in terms of sales value. In 1956 sales of other products by the industry amounted to $1,771,000,000. Of this amount, $1,168,000,000 was for missiles procurement. It was noted in the last chapter that missiles procurement is expected to rise and aircraft procurement is expected to fall until in 1961 expenditures for missiles will exceed expenditures for aircraft procurement.

The above attests to the changing character of military demand for the products of the aircraft industry under the impact of technological innovation. The future of the military market sector is dependent in large measure on whether combined expenditures on missiles and aircraft will be less than, as much as, or greater than previous expenditures on aircraft. The possibility of a much slower rate of depreciation and obsolescence of a guided missiles inventory necessitating little replacement may mean a diminishing military market sector in the near future.

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[32]Lee, Aircraft Facts and Figures, 1957, p. 16.

Market classification.--Domestic producers of military aircraft sell in a market in which there is but one buyer, the United States Government. In its position as the only buyer, the Government exercises complete control over quality of output and quantity produced, and considerable influence over price.[33] Even after the Government has entered into a contract with a firm, which has been selected on a competitive basis to produce a production model, under the terms of its contract the Government has recourse to reclaim what it regards as the firm's excess profits.[34] In effect then, the Government has the prerogative of saying the agreed upon price was too high initially. It can renegotiate the terms of the contract and claim what it considers to be excess profits to the firm, or in effect, lower the price of aircraft already purchased. The demand side of the market for military aircraft and products of the industry is, therefore, decidedly monopsonistic in structure.

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[33]All aircraft produced must pass rigid performance inspections of the service purchasing them before they are accepted. Quantity is controlled because military aircraft are produced on a contract basis, hence few production models are produced unless the Government has indicated its intention to purchase them.

[34]U.S. Statutes at Large, 65 (1951), 7-25.

CHAPTER III

ORGANIZATION AND TECHNOLOGY OF PRODUCTION

Organization of Production

In the words of the President's Air Policy Commission, "The aircraft manufacturing industry covers all those manufacturers whose products are included in finished aircraft, military or civil."[1] The aircraft and parts industry is more meaningfully broken down into establishments classified into four major subdivisions, namely: (1) Aircraft (establishments primarily engaged in assemblying and manufacturing complete aircraft such as airplanes, balloons, airships, passenger and cargo gliders, heliocopters, and autogiros); (2) Aircraft engines (aircraft engines and engine components); (3) Aircraft propellers (aircraft propellers and propeller parts); and (4) Aircraft equipment (aircraft parts and auxilliary equipment not classified elsewhere.)[2]

In 1957 twenty-six companies in the industry were engaged in manufacturing components for and assembling 79 different models of aircraft ranging from the Hiller-Hornet

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[1]President's Air Policy Commission, op. cit., p. 49.

[2]This is the classification used by the Bureau of the Census. See U.S. Bureau of the Census, 1954 Census of Manufacturers, pp. 1-2.

heliocopter having an empty weight of 544 pounds to the Boeing B-52D which weighed more than 400,000 pounds.[3] The variety of models were designed to perform a wide range of functions but primarily as pleasure, business, commercial passenger, commercial cargo, military fighter, military bomber, and military transport aircraft. The 1956 Aircraft Year Book lists thirteen aircraft engine producers producing over 100 different models that year.[4] The World Aviation Directory for 1957-1958 lists ten propeller manufacturers in the United States[5] although Aeroproducts, division of General Motors Corporation, and Hamilton Standard, division of United Aircraft Corporation, were by far the largest producers.

In 1954 there were an estimated 50,000 suppliers in the industry, in every state and major city in the United States, including the prime producers of the major components of airframes, aircraft engines, and propellers but most of whom were suppliers and subcontractors.[6] Of the

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[3]For illustrations and specifications of the different aircraft produced in 1957, see National Aviation Education Council, U.S. Aviation Today, 1957 (Washington: National Aviation Education Council, 1957), pp. 16-94.

[4]Hamlin and Miller, Aircraft Year Book, 1956, pp. 285-363.

[5]Marion E. Grambow, (ed.), World Aviation Directory, 19 (Washington: American Aviation Publications, 1957), 223-224.

[6]U.S. Congress, House of Representatives, The Aircraft Industry, Hearings before the Subcommittee No. 4 on Small Business, Pursuant to H. Res. 114, 84th Cong., 2d Sess. (Washington: Government Printing Office, 1956), pp. 234-235.

total disbursements of $8,744,270,000 of 35 aircraft and aircraft components manufacturers in 1954, $4,759,320,000 was paid out to subcontractors and suppliers.[7] Of this amount, $2,030,000,000 went to small businesses[8] and the remaining $2,700,000,000 went to larger business organizations.[9] Douglas Aircraft Company, for example, calculated that 47.2 cents of its procurement dollar went for outside purchases. Of its $493,537,300 of outside purchases, 62 per cent went to small businesses.[10] Another manufacturer (unnamed) estimated that 44 per cent of the airframe weight of a giant military transport it produced was subcontracted. In this case the Air Force paid 28 cents out of each dollar directly to suppliers for "government furnished equipment."[11] Of the remaining 72 cents the manufacturer paid 47 cents in subcontracting and 25 cents remained with the manufacturer.[12]

The above information illustrates these unique characteristics of the organization of aircraft manufactur-

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[7] Ibid.

[8] A "small business" is considered by the aircraft industry to be one which employees 500 or less workers.

[9] U.S. Congress, The Aircraft Industry, loc. cit.

[10] Ibid., p. 45.

[11] This is aircraft equipment for military aircraft which the Government purchases and furnishes directly to the airframe manufacturer such as engines, propellers, various accessories, and instruments.

[12] Planes, Vol. 13 (April 29, 1957), p. 1.

ing: 1. There is a wide variety of products produced by the industry with respect to the products of airframes, engines, propellers, and to an even greater extent with respect to the thousands of parts produced which go into the construction of the aircraft; 2. Production of the components of the aircraft is carried on by a large number of firms (more than 50,000) scattered over the entire nation; and 3. Most of these firms in the industry are producing assemblies, subassemblies, or parts which they are supplying directly or indirectly to a much smaller number of producers of airframes, aircraft engines, and propellers.

The role of the airframe manufacturer.--Ultimately it is the airframe manufacturer who is responsible for the final product--the completed airplane. It is this branch of the industry to which all the others channel their production. It is the airframe manufacturer who designs and builds the basic structure and assembles the numerous components. In the production of commercial aircraft the airframe manufacturer purchases the components from their respective producers. In the case of military aircraft, he usually buys the engines, propellers, accessories, and instruments separately.[13] It then becomes the task of the

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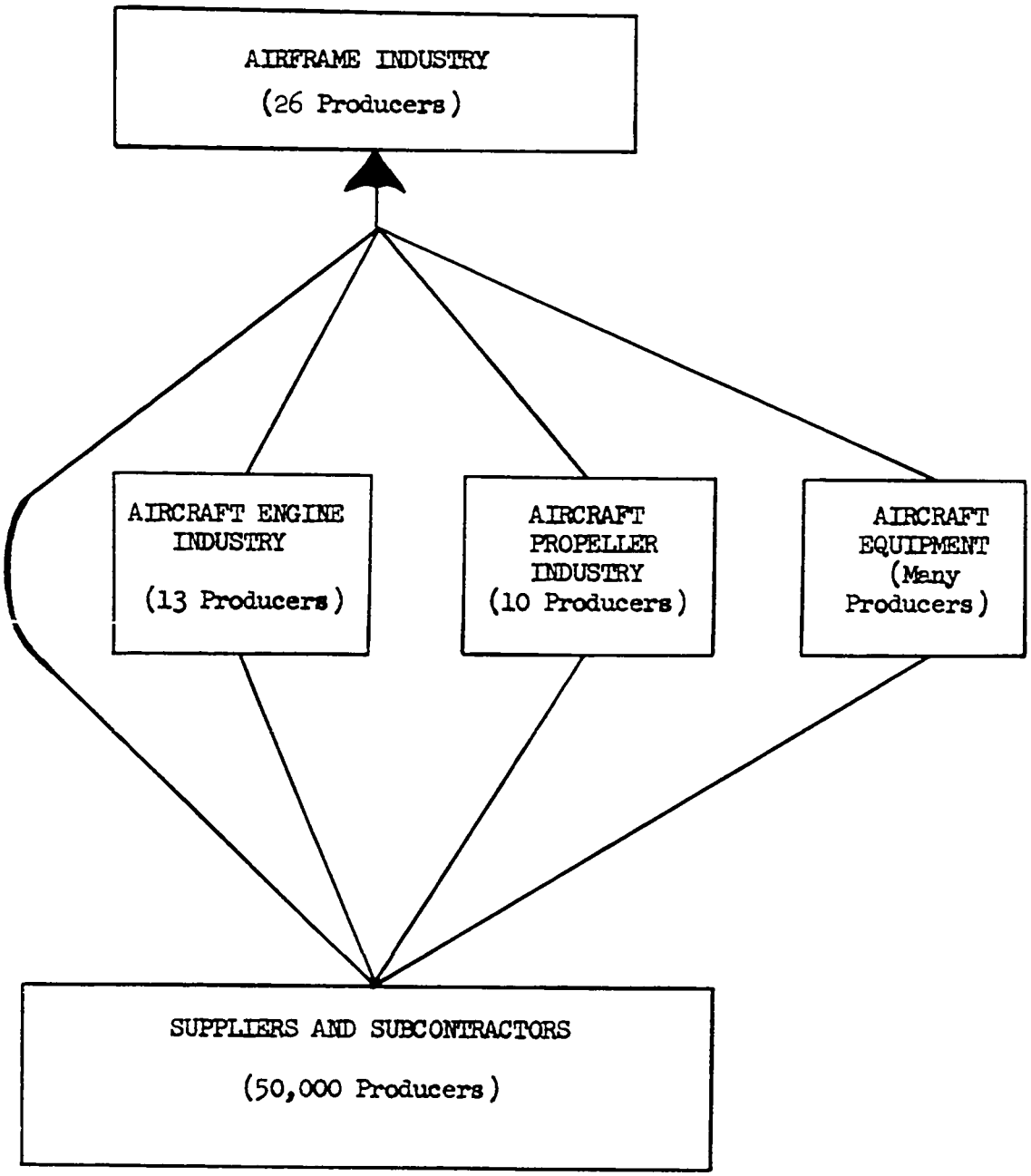
[13]President's Air Policy Commission, op. cit., p. 50. Since 1953 this policy has been followed to a lesser extent. The Air Force since that time has been applying the weapons system approach to procurement of what formerly was "government furnished equipment," leaving the procuring of such components as a responsibility of prime airframe manufactur-

FIGURE 7

ORGANIZATION AND FLOW OF PRODUCTION IN UNITED STATES AIRCRAFT MANUFACTURING



Source: U.S. Aviation Today, 1957; World Aviation Directory, 1957; Aircraft Year Book, 1956.

airframe manufacturer to assemble them with the basic structure, the airframe, which he manufacturers, and to test the final aircraft before delivery. Thus the basic functions of the airframe industry are: (1). The designing and the building of the airframe; and (2). The assembling of the aircraft. It is this branch of the industry with which the rest of the chapter is concerned.

The airframe industry is the largest segment of the aircraft manufacturing industry. Of the major industrial subdivisions of aircraft manufacturing, i.e., the airframe and parts industry, the aircraft engine and parts industry, and the aircraft propeller and parts industry, there were more firms engaged primarily in airframe manufacturing than the other two combined.[14]

Sales of the airframe industry, exclusive of engines and other equipment, also exceed those of the other two segments of the entire aircraft industry. Table 20 shows that for the five year period 1952-1956 sales of the entire industry were $35,841,000,000 and sales of airframe manufacturing alone were $25,020,000,000 or 70 per cent of total

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ers. The Air Force still furnishes major components such as engines as before. (Goldberg, op. cit., p. 220.)

[14]See Figure 7, supra. This is not to say that there were not more firms engaged in the manufacture of these components. The Bureau of the Census lists as many as 72 manufacturers engaged in manufacturing or assembling of complete aircraft. Also in the 72 are included establishments engaged in modifications and conversion of aircraft. (U.S. Bureau of the Census, 1954 Census of Manufacturers, p. 3.)

TABLE 20

RELATION OF AIRFRAME INDUSTRY TO ENTIRE AIRCRAFT INDUSTRY, 1952-1956[a]

	1952-1956	1956
Sales, Entire Aircraft Industry (Millions of Dollars)	$35,841	$7,725
Sales, Airframe Industry (Millions of Dollars)	$25,020	$5,554
Percent Airframe of Aircraft Industry Sales	70%	72%
Percent Airframe Sales		
Military	88%	85%
Civil	12%	15%
Entire Aircraft Industry Floor Space (Millions of Square Feet)	--	138.4
Airframe Industry Floor Space (Millions of Square Feet)	--	101.5
Percent Airframe of Entire Industry Floor Space	--	73%
Entire Industry Employment (Thousands of Employees)	--	693.3
Airframe Industry Employment (Thousands of Employees)	--	512.0
Percent Airframe of Entire Industry Employment		74%

[a]Entire Aircraft Industry refers to producers of airframes and parts, aircraft engines and parts, and aircraft propellers and parts.

Source: Aviation Facts and Figures, 1957.

industry sales. This percentage had not changed appreciably in the last year of this period, 1956, when airframe sales represented 72 per cent of total aircraft industry sales. With respect to the civil and military market, the table indicates that 88 per cent of all airframe sales were to the Government. The remainder was divided between the commercial transport aircraft market and the utility aircraft market. Of the remaining 12 per cent, roughly 10 per cent of total airframe sales was for commercial transports and the other two per cent represented the purchases of utility aircraft.[15]

Another indicator of the prominence of the airframe branch of the aircraft industry is the relation of floor-space utilized in the manufacture of airframes and aircraft assembly to that of floor space utilized in the entire industry. In 1956, 138,400,000 square feet of floor space were used in all of aircraft manufacturing while 101,500,000 square feet, or 73 per cent of the total floor space, were used in the airframe industry alone.

In 1956 employment in airframe manufacturing was 512,000 employees compared to 693,300 employees in the entire aircraft industry, which represented 74 per cent of the total. Employment of production workers[16] was 497,000 for

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[15]This approximate division is arrived at from the data on the relation of utility to total civil aircraft production. See Chapter II, supra.

[16]By production workers is meant those employees, other than overhead personnel, who are engaged directly in airframe manufacture and aircraft assembly.

the entire industry. Seventy-five per cent of this amount, or 369,600 production workers, represented the portion of workers engaged directly in airframe production.[17]

The Extent of Concentration in Airframe Production

In 1950, seventeen of the largest 1,000 manufacturing companies in the United States were in aircraft manufacturing.[18] Of the 12 largest aircraft companies in the industry that year, 64.9 per cent of the value of output was produced by the airframe branch of the industry and of this amount the four largest airframe companies did 63.5 per cent of the airframe business.[19] These companies were Boeing, Consolidated-Vultee,[20] Lockheed, and North American.[21]

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[17]As is noted concerning Table 20, the entire industry is considered to be airframes and parts, aircraft engines and parts, and aircraft propellers and parts. Not included in the data are "other aircraft parts and equipment" which overstates somewhat the importance of the airframe segment in relation to all manufacturing pertaining to aircraft. If a comparison were made of airframe sales to the total aircraft industry sales including this category, then airframe sales in 1956 would be 58 per cent of total sales and airframe employment would be 64 per cent of total employment. See Lee, Aviation Facts and Figures, 1957, pp. 16, 56.

[18]Federal Trade Commission, Report of the Federal Trade Commission on Industrial Concentration and Product Diversification in the 1,000 Largest Manufacturing Companies: 1950. (Washington: Government Printing Office, 1957), p. 246.

[19]Ibid., p. 123.

[20]In April 1954 this organization was renamed Convair when it became a division of General Dynamics Corporation. Ibid.

[21]Ibid., p. 121.

These companies accounted for 55 per cent of the sales in the entire industry in 1950, and 42 per cent of the sales went to eight smaller companies.[22]

Concentration in military airframe production.--Since the 1950 report of the Federal Trade Commission, the extent of concentration in airframe manufacturing has continued and, it appears, even has increased somewhat. Concentration in airframe manufacturing from 1952 to 1956 is portrayed in Table 21. These twelve companies account for approximately 95 per cent of the sales of airframe companies assembling completed aircraft.[23] Convair, a major airframe producer, has not been included because General Dynamics Corporation, of which Convair is a division, does not supply data relating only to aircraft production. Actually, Convair would rank somewhere among the top five producers. For this reason, production concentration among the top twelve producers is even greater than Table 21 indicates. Douglas, Boeing, North American, and Lockheed accounted for 66 per cent of the sales for the period 1952-1956. If Convair were included in the top five, these five would account for closer to 75 per cent of the sales in this

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[22] Ibid.

[23] This is an estimate of the author. Note that the sales of these twelve companies exceeds that of the airframe industry noted in Table 20. This is perhaps due to the exclusion of non-airframe parts in the accounting of the latter while Table 21 takes into consideration the total sales of the twelve companies including non-airframe parts which have not been supplied as Government furnished equipment.

TABLE 21

INDICES OF CONCENTRATION, TWELVE MAJOR AIRFRAME COMPANIES, 1952-1956

Company	Sales, (Millions of Dollars)		Percent of Sales, Twelve Companies		Percent of Company Sales, 1955		Net Worth, 1956		Floor Space, 1956		Employment, 1956	
	1952-1956	1956	1952-1956	1956	Military	Civil	(Millions of Dollars)	Percent of Twelve Companies	Thousands of Square Feet	Percent of Twelve Companies	Thousands of Employees	Percent of Twelve Companies
Douglas	$4,255	$1,074	18.0%	19.0%	88.9%	11.1%	$152.9	17.3%	16.5	20.0%	80.4	18.2%
Boeing	4,550	1,006	19.3	17.9	99.7		148.7	16.8	13.2	16.0	82.0	18.6
North American	3,327	914	14.1	16.2	99.6		152.6	17.3	11.0	13.4	70.8	16.0
Lockheed	3,408	743	14.4	13.2	80.9	19.1	112.1	12.7	14.2	17.2	61.0	13.8
Martin	1,250	359	5.3	6.4	99.7		63.7	7.2	5.7	6.9	29.2	6.6
Republic	2,040	346	8.6	6.1	99.9		46.4	5.2	2.9	3.5	18.4	4.2
Northrop	947	322	4.0	5.7	99.9		28.3	3.2	3.2	3.9	22.0	4.9
Bell	881	216	3.7	3.8			39.1	4.4	3.9	4.7	20.7	4.7
Grumman	1,108	198	4.7	3.5	99.0		47.5	5.4	3.3	4.0	13.0	3.0
McDonnell	679	186	2.9	3.3	100.0		27.8	3.1	3.3	4.0	18.0	4.1
Fairchild	761	155	3.3	2.7	99.4		36.9	4.2	2.8	3.4	11.9	2.7
Chance Vought	414	118	1.7	2.1	99.9		28.7	3.2	2.5	3.0	14.3	3.2
Totals	$23,624	$5,637	100.0%	100.0%			$884.7	100.0%	82.5	100.0%	441.7	100.0%

Sources: Moody's Industrial Manual, 1957; U.S. Congress, Aircraft Production Costs and Profits, 1956; Aircraft Industries Association; Author's questionnaire compiled by companies.

period.[24] Excluding Convair, this left 34 per cent of the sales to the next eight producers, the smallest of which had sales of $118,000,000 in 1956 and 2.1 per cent of the sales of the twelve companies. The top two producers, Douglas and Boeing did 37 per cent of the business in 1956 and the lowest two producers accounted for 4.8 per cent of the sales of that year.

Other indicators of concentration, net worth, floor space used, and employment were generally directly correlated to sales volume as well as to each other. Table 22 indicates the ranks of the same twelve companies with respect to these factors of concentration. The top four producers occupy all the top four positions in terms of sales, net worth, floor space used, and employees, although the converse is not in all cases true for the lowest four producers.

Table 21 also reveals that the overwhelming dependence of these top producers on the military market. Boeing is the largest producer of aircraft for the military market in sales; in fact, it is second only to General Motors as a defense contractor.[25] All of the above firms mentioned

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[24]This calculation is based on sales data presented during the recent investigation of the airframe industry. See U.S. Congress, Aircraft Production Costs and Profits, pp. 2724-2725.

[25]Between January 1, 1950 and June 30, 1957, Boeing's sales to the Government accounted for 4.4 per cent of all defense sales while General Motors accounted for slightly more, 4.5 per cent of the total. Ben S. Lee (ed.), Aviation Facts and Figures, 1958 (Washington: American Aviation Publications, 1958), p. 72.

TABLE 22

RELATIVE RANKS OF COMPANIES IN TERMS OF CONCENTRATION INDICATORS, 1956

Company	Sales	Net Worth	Floor Space	Employment
Douglas	1	1	1	2
Boeing	2	3	3	1
North American	3	2	4	3
Lockheed	4	4	2	4
Martin	5	5	5	5
Republic	6	6	10	8
Northrop	7	11	9	6
Bell	8	8	6	7
Grumman	9	7	7	11
McDonnell	10	12	7	9
Fairchild	11	9	11	12
Chance Vought	12	10	12	10

Sources: Moody's Industrial Manual, 1957; U.S. Congress, Aircraft Production Costs and Profits, 1956; Aircraft Industries Association; Author's questionnaire compiled by companies.

except Fairchild, Bell, and Chance Vought were among the top 20 defense contractors in terms of sales between 1950 and 1957.[26] In 1955 the only firms of the twelve which sold more than one per cent of the value of their output to other than the Government were Douglas and Lockheed. Were Convair included in the accounting this also could be said of it because of its success in the commercial transport field. But even Lockheed, which had a larger portion of its sales in the civil market than Douglas, was dependent on the Government for 80.9 per cent of its total sales.

Sales of these companies are not indicative of airframe production and assembly alone. Each has a different product-mix in terms of that which it produces. As examples, in 1956 Boeing was engaged in producing the very heavy B-52 Stratofortresses, KC-135 Stratotankers, the 707 and the 717 jet transports, turbine-powered air-compressors, gas turbine engines, and long-range Bomarc Missiles.[27] Douglas was engaged in the development or production of as many as 16 different aircraft types for the military services including jet bombers, attack bombers, early warning radar aircraft, jet fighters, reconnaissance aircraft, logistic transport aircraft; nine different missile projects; and the DC-7 and DC-8 commercial aircraft.[28] Most of the

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[26] Ibid.

[27] Moody's Investors Service, Moody's Industrial Manual (New York: D. F. Shea, 1957), p. 1406.

[28] Ibid., p. 2533.

companies were conducting government sponsored research and development projects on aircraft or missiles. All the companies except Grumman and Republic were engaged in missile research and development.[29] Nevertheless, each of these companies was engaged primarily in aircraft production.

Each company has to some extent specialized in the production of a particular class or particular classes of aircraft. Boeing, for example is best known for its long range heavy bombers and transports as is Convair (formerly Consolidated Vultee). Both Douglas and Lockheed are known for their transports but they also engage in production of lighter weight military aircraft including fighters. Douglas and Lockheed are the most diversified in their aircraft production. Fairchild too is recognized as a producer of transports. The remaining companies are known more for the production of lighter aircraft such as fighters, light bombers, reconnaissance, and sea planes. Martin and Grumman traditionally have been recognized for their production of naval planes; North American, Republic, and Northrop traditionally have produced fighters, etc. As a general rule, most of the companies are recognized for their ability to produce aircraft of a particular class or classes.[30]

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[29]See Lee, Aviation Facts and Figures, 1958, pp. 41-42.

[30]This can be affirmed by viewing the numerous models of aircraft which have been produced over the years by the twelve companies and observing how each company has tended

Concentration in commercial transport airframe production.--The commercial transport aircraft market was supplied principally by three producers from 1953 to 1957, namely, Convair, Douglas and Lockheed. Boeing and Martin, which were both in the postwar market, have not produced commercial transports since before 1953 although the former is expected to be a significant competitor as soon as its models of the 707 and 717 jet transports are ready for delivery in 1958. Table 23 illustrates the extent of concentration in commercial transport production during the period 1953-1957. Douglas has produced 46.3 per cent of this class of aircraft during this period while Convair produced 29.7 per cent and Lockheed 23.9 per cent. These producers are engaged in production and experimentation on jet and turbo-prop aircraft for commercial use some of which should be ready for commercial operation in 1958.

Concentration in utility airframe production.--As in the production for the military market and the commercial transport market, concentration of production of utility aircraft is very pronounced. Four companies produced more than 93 per cent of the aircraft shipments and more than 96 per cent of the value of shipments in 1957. Table 24 shows the extent of this concentration since 1952. Although Cessna has produced more planes than any other of the top four, Beech's sales of $125,300,000 for the period

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to specialize in certain categories of aircraft production. See Rolfe and Dawydoff, op. cit., pp. 28-312.

TABLE 23

CONCENTRATION IN PRODUCTION OF COMMERCIAL TRANSPORT AIRCRAFT, 1953-1957

Year	Total	Convair		Douglas		Lockheed	
		340	440	DC-6	DC-7	1049	1649
1953	209	101	--	69	11	28	--
1954	198	61	--	41	48	48	--
1955	113	14	--	14	30	55	--
1956	206	--	57	39	67	43	--
1957	323	--	79	44	123	42	35
Totals	1049	312		486		251	

Source: Aviation Facts and Figures, 1958.

TABLE 24

CONCENTRATION IN UTILITY AIRFRAME PRODUCTION, 1952-1957

Year	Total Shipments	Total Sales (Millions)	Aero Design		Beech		Cessna		Piper		All Others	
			Number	Value (Millions)	Number	Value (Millions)	Number	Value (Millions)	Number	Value (Millions)	Number	Value (Millions)
1952	3,058	$ 26.2	39	$ 2.0	414	$ 9.9	1,373	$ 9.2	1,161	$ 4.9	71	$ 0.2
1953	3,788	34.5	69	4.3	375	9.5	1,434	12.1	1,839	8.3	71	0.3
1954	3,071	43.5	67	4.5	579	20.1	1,200	10.7	1,191	8.1	34	0.1
1955	4,434	68.3	72	5.1	680	24.9	1,746	21.9	1,870	16.0	66	0.4
1956	6,738	103.8	154	11.2	724	28.8	3,235	38.5	2,329	23.5	296	1.8
1957	6,118	99.7	139	9.9	788	32.1	2,489	31.0	2,300	23.3	402	3.4

Source: Aviation Facts and Figures, 1958.

slightly exceeds Cessna's sales of $123,400,000. Of the total shipment value for the period, Beech produced 33.3 per cent, Cessna produced 32.8 per cent, Piper produced 22.4 per cent, Aero Design produced 9.8 per cent, and all other producers only 1.6 per cent. This 1.6 per cent of sales was shared mostly by five other producers, namely: Call Air, Champion, Helio, Mooney, and Taylorcraft. Champion was the largest producer of these in 1957 with 217 aircraft shipped at a net billing price of $1,045,000.[31]

The top three producers of utility aircraft also produce aircraft for the Government. Beech listed its sales to the Government in 1956 at $43,447,000 compared to sales in the civil market of $32,092,000.[32] Cessna listed its sales to the Government at $24,526,000 compared to $37,703,000 receipts from commercial sales in 1956.[33] Piper received only $1,865,307 from military sales and subcontracting compared to $23,218,398 of commercial sales that same year.[34]

Classification of the market structure.--It has been

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[31]Lee, Aviation Facts and Figures, 1958, p. 81.

[32]Data was secured from an answer to a questionnaire submitted by the author to Beech Aircraft Corporation.

[33]Data was secured from an answer to a questionnaire submitted by the author to Cessna Aircraft Corporation.

[34]Data was secured from an answer to a questionnaire submitted by the author to Piper Aircraft Corporation.

demonstrated above that the output and sales of the airframe industry is concentrated among several important producers. Not only is there pronounced concentration in the production and sales of the entire airframe industry, but also there is concentration, and to a much greater extent, with respect to the three primary market subdivisions which these producers supply, i.e., the military market, the commercial transport market, and the utility plane market. Twelve airframe producers account for an estimated 95 per cent of the sales in the military market; three domestic producers supply the market for commercial transports; and four producers account for 98 per cent of the sales of utility aircraft. The supply side of the market in each of the three cases is therefore oligopolistic in structure.

Causes of concentration in the airframe industry.--Concentration in airframe production has resulted largely from the decisions of the services to purchase from particular companies and the amounts which they have decided to purchase from each. No airframe firm is large in relation to its closest competitors which does not sell primarily to the Government. Contracts from the Government have enabled the recipient firms to grow in terms of the output, sales, production facilities, net worth, and number of employees to mention a few of the most significant indicies of size and concentration. The nature of military defense has demanded products of technological superiority. The firms

which have indicated their ability to supply these products have been the ones which have received the Government contracts and have grown.

The pattern of concentration was mostly established in the late 1920's and early 1930's when companies within the aviation industry were merging for financial strength.[35] Seven of the top eight organizations engaging in airframe manufacturing in the period 1927 to 1933 were among the top 13 airframe producers during World War II.[36] After the war when the pre-war non-airframe producers had withdrawn from the industry, these same firms or offshots of them were once again the leaders of the industry. All of them except Great Lakes and Curtiss-Wright were among the top 13 producers in 1956; and of the top 13 airframe producers during World War II, 10 were among the top 13 producers in 1956.[37] The reason why all of the top producers in 1956 were not also the top 13 producers during World War II was largely because of the priority which the Government gave to several of the pre-war non-aircraft producers to insure capacity output.[38] As can be observed from the tables cited, some producers have lost their relative positions of prominence among the

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[35]See Chapter One, supra.

[36]Compare Table 3 with Table 11.

[37]Compare Table 11 with Table 22.

[38]Such were General Motors and Ford. Curtiss-Wright has since dropped out of airframe production and is specializing in aircraft engine production.

top 13 but none of the leading producers in 1957 is new to the industry since 1939. Certainly these firms have had to innovate to continue to survive, and the extent to which any single firm was more successful in so doing undoubtedly determined the extent to which it surpassed the relative positions of the others in sales. Undoubtedly just having had past experience in aircraft production has enabled these leaders to continue to get Government contracts over less experienced producers. The advantages of lower unit prices resulting from economies of scale coincident with large orders to single firms has been another reason why the Government has concentrated its orders rather than ordering small amounts from many firms.[39]

Technology of Production

Factors determining the technology used.--It was noted that Government procurement policies, by distributing orders among a relatively small number of producers, has perpetuated concentration of airframe production in the industry. This concentration of production among a few producers in turn has been the most important single condition determining the pervasive characteristic of the technology of production in the airframe industry--that of large scale production.

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[39]The bases for these decisions of the services in purchasing how much and from whom relate directly to the procurement policies of the services which is discussed in detail in Chapter Four and Chapter Five, infra.

The scale of production, which represents the eventual quantity of a model which one of the services, or less frequently, civil purchasers, has indicated will be ordered, determines the engineering and tooling philosophy to be used.[40] Prior to 1940, aircraft had been built a few at a time. As one producer described aircraft purchases at that time: "Ten ships was a good order, one hundred a stroke of fortune."[41] Because of the small numbers ordered of any particular design, aircraft production was a shop operation as was the automotive industry originally under similar circumstances.[42] In these circumstances much of the work was done by hand and much improvising was done. The small orders did not justify the expensive tooling of a production job. For if large fixed costs were allocated over a small number of units of output this would mean larger average total costs per aircraft than if more laborers were used instead to produce the same number of aircraft. With the larger quantities of aircraft ordered and the increase in total expenditures on aircraft since 1938, the method of production has changed from one which is best described as a shop operation, employing custom manufacturing techniques, to mass production methods oriented to an assembly line.[43]

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[40]U.S. Congress, Aircraft Production Costs and Profits, pp. 1762-1766.

[41]Stout, op. cit., p. 103.

[42]Ibid., pp. 104-105.

[43]Mannie Kupinsky, "Growth of Aircraft and Parts Industry, 1939-1954," Monthly Labor Review, 77 (December, 1954), 1320.

Under these circumstances heavy capital investment has resulted in lower unit costs when allocated over a larger number of units of output In 1939, airframe sections of the larger metal airplane; were stamped from aluminum and assembled by skilled workmen using various jigs, fixtures, and hand tools.[44] By 1954 airframe sections were being formed by huge stretch, extrusion, and forging presses and milling machines. The number of pieces of an airframe were reduced by making larger and integrally stiffened sections for the bigger and faster aircraft.[45] Particular aircraft components were assembled at certain stages of the assembly line production process.

The performance characteristics desired of aircraft today also has been a conditioning factor resulting in more extensive use of capital in airframe production. Largely because of the high rates of speed desired, production equipment required to build aircraft is more costly. Now, for example, to give added strength for the greater stresses at higher rates of speed, giant skin mills are used to taper the thickness of heavy wing plates, and to form the heated plates to the wing curvature, huge presses are used. This job alone requires a $500,000 investment in machine tools; the comparable task in 1940 was accomplished by a few men with $50 rivet guns.[46] The tooling cost for the

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[44] Ibid., p. 1323. [45] Ibid.

[46] R. A. Lambeth, "Progress of the Aviation Industry," Commercial and Financial Chronicle, 180 (December 23, 1954), 34.

P-51 Mustang fighter in 1942 was $2,044 per airplane based on the first 620 units.[47] The tooling cost for the F86D Sabre Jet in 1952 was $23,425 per airplane based on the first 620 units.[48] With total costs of $26,741 and $179,309 for the P-51 and the F-86D respectively,[49] this means that tooling costs were only seven per cent of total costs for the P-51 compared to 13 per cent of total costs for the F-86D. Research equipment is also more costly. In 1942, a wind tunnel cost North American $350,000; in 1954 a wind tunnel necessary to conduct research in supersonics cost $5,000,000.[50]

The cost of production facilities has become so great that no company has indicated a willingness to privately finance expansion for large scale production. The Government therefore has supplemented the plant and equipment of the airframe industry enabling companies to produce at the higher levels and to provide a reserve of standby mobilization capacity for emergencies. The Air Force had built, and loaned to industry, heavy presses for manufacturing large sections of aircraft in one piece. By April, 1957, nine of these heavy presses were in operation, including two 50,000 ton forging presses, and one 12,000 ton

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[47]"The Price of Security," Automotive Industries, 106 (May 1, 1952), 52.

[48]Ibid.

[49]Ibid.

[50]Lambeth, loc. cit.

extrusion press.[51] By July, 1956 there were 147,420 machine tools valued at $1,300,000,000 in the Air Force inventory; of this number, 104,892 were in use by the industry.[52] The twelve leading airframe manufacturers were using government owned plant equipment valued at $895,000,000 in contrast to their own plant and equipment valued at $349,000,000 in 1956.[53]

Stages of the airframe production process.--There are literally thousands of separate tasks which have to be integrated in the process of producing an aircraft. There are, however, several more-or-less distinct stages in the production process during which these numerous tasks are accomplished. That which follows is a delineation of several of the major phases in a typical production process with the Government as the customer and a brief discussion of some of the more important tasks which are performed during each phase.

1. Decision by the Government to purchase an aircraft with certain performance specifications. The airframe industry is essentially a contracting industry in which new models are seldom produced before contracts are awarded. This is true of production for the Government whereas pro-

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[51] Goldberg, op. cit., p. 216.

[52] Ibid.

[53] "Report from Congress: Is the U.S. Taxpayer Getting His Money's Worth in Planes?" U.S. News and World Report, 41 (July 27, 1956), 108.

duction of aircraft for sale on the civil market sometimes takes place in advance of contracts. When the Government decides that it needs aircraft to fulfill certain performance specifications, the service requesting the aircraft invites producers which have demonstrated an ability to produce aircraft of this type (for example, fighter aircraft) to submit designs and plans of aircraft in line with the specifications which the Government has presented. Specifications include such factors as altitude of flight, range, speed, defensive armament necessary, size of bomb load if it is a bomber, etc. From there it becomes the task of the engineering departments of each aircraft company to design an aircraft which is theoretically capable of performing in accordance with the specifications of the Government. With the basic design completed, wind tunnel tests of a small scale model may be conducted. Adjustments are made until the design is believed capable of successful performance. Aircraft designs and plans are submitted by the competing companies to the Government for review.

2. Granting of one or more development contracts. The company which has submitted the design which appears to be the most capable of performance in accordance with the specifications is given a development type contract by the Government to produce one or more experimental prototypes. Frequently the Government has awarded such contracts to more than one company in the competition for different promising designs. The next step for a successful company is to build

a full size wooden replica, called a mock-up, of the plane to be. By use of the mock-up the engineers calculate just how to construct the many parts which are to be assembled in the experimental model. The shapes, sizes, and locations of parts are reproduced on blue prints which depict how the parts are fitted together to construct the experimental airplane. After the prototype has been constructed, extensive tests are conducted and modifications are made where necessary until the design is proven capable of successful performance.

3. Granting of the production contract. If the service is satisfied with the performance of an experimental model of a company, the Government then awards it a production contract for a specified number of aircraft. When the production contract is awarded, this means that a great deal of production planning must be done. Arrangements must be made to procure supplies and subassemblies from countless suppliers and subcontractors so that they are available when needed. Tooling of the plant entailing getting all the devices used to construct the aircraft, many of which must be specially made, is a major step. The plant must be rearranged in order that the plant layout will assure a smooth and efficient flow of work and materials inside the plant, from shop to shop, from section to section, down the final assembly line.

4. Final assembly. With all in readiness, production can begin on the first aircraft. Each aircraft is

tested and certified before delivery to the purchasing service. The lead time, the time from the initial Government decision to buy the new type aircraft until the first aircraft rolls off the assembly line, is typically from four to five years.[54]

Economies of scale.--A consequence of the technology of large scale production in the aircraft industry is the economies which are realized from it. Evidences of such economies in the airframe industry were brought into sharp relief during World War II which was the first time that very large scale production took place and mass production techniques were used extensively. With the greater specialization and division of labor afforded, the Air War Production Council noted, for example, that in the production of a typical fighter every doubling of the total number ordered meant a cut of almost 75 per cent in manhours required,[55] attesting to declining average variable costs when output was extended. In one case, the first plane took 157,000 manhours to produce, the thousandth took only 7,800 manhours.[56] By 1944, with greater experience and larger

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[54]For a more detailed description of the steps in the procurement and production process, see Lambeth, op. cit., p. 6; James Hay Stevens, The Shape of the Aeroplane (New York: Roy Publishers, 1953), pp. 113-115; and National Aviation Education Council, Aircraft Number 116, The Story of the Aircraft Plant (Washington: National Aviation Education Council, 1957), pp. 7-32.

[55]Cleveland and Graham, The Aviation Annual, 1945, p. 78.

[56]Ibid.

quantities of output, almost every plane built cost taxpayers 20 to 40 per cent less than the same model constructed two years previously.[57] For example, the B-24 cost the Air Force $238,000 per unit for an order of 12 in March of 1942. For an order of 4,500 in March of 1944 the per unit cost was $137,000.[58]

Continued concentration of orders with a small number of firms has permitted economies of scale in the postwar period. Table 25 gives examples of five different models of aircraft produced, the quantities ordered under separate contracts, and the negotiated prices per unit at which the aircraft were sold. The orders for each aircraft type are in chronological sequence from top to bottom. As a general rule it is noted that as output was extended, with successive contracts, price per unit decreased. This is not always true because a new contract can call for modifications which will necessitate some retooling and changes in the production process which will affect production costs. The C119H, an experimental model, cost $3,832,237 to produce. Cost per plane on production models of the C119F declined from $390,389 to $195,235 with successive orders. Declining costs per unit occurred in most cases in the production of the Martin B-57, the Boeing B-47 and B-52, and North American's F-86 as output was extended. Average fixed costs declined as heavy research and development costs and

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[57] Ibid.

[58] Ibid.

TABLE 25

EXAMPLES OF DECREASING AIRCRAFT PRICES WITH INCREASING PRODUCTION

Company and Model of Aircraft	Number of Aircraft Purchased Per Contract	Price Per Aircraft
Fairchild Engine and Airplane Corporation		
C119H	1	$3,832,237
C119F	1	390,589
C119F	411	350,001
C119F	440	262,466
C119F	135	279,355
C119F	19	378,018
C119F	88	195,235
The Martin Company		
B-57A	8	$5,920,382
RB-57A	67	835,751
B-57B	102	679,100
Boeing Airplane Company		
B-47A,B	97	$2,458,698
B-47	510	1,157,971
B-47	227	1,156,082
B-47	252	1,004,203
B-52-B,RB	20	$19,783,854
B-52	33	5,351,783
B-52	35	4,709,002
B-52	50	3,940,523
North American Aviation		
F-86D	153	$ 535,680
F-86D	638	154,277
F-86D	188	187,868
F-86D	901	154,608
F-86D	624	148,038
F-86E,F	360	129,426
F-86F	441	185,814
F-86F	967	111,886
F-86F	259	141,929
F-86F	157	120,962

Source: U.S. Congress, Aircraft Production Costs and Profits, 1956.

production tooling costs were allocated over the greater number of units produced. Average variable costs declined notably as job procedures became established. All the data points to a conclusion that aircraft manufacturing is a decreasing cost industry.

Scale of output undoubtedly is an important factor lowering aircraft prices, but prices of new models of aircraft have been rising considerably since World War II. This can be explained largely because of inflation, resulting in increased factor costs; the larger size of aircraft in each category; and the greater complexity of the aircraft due to the superior performance required of each successive model.[59] If it were not for the superior production techniques and higher level of skill and experience in aircraft manufacture, prices would be even higher.[60]

Changing composition of the labor force.--Another consequence of the technology of large scale production is the changing composition of the labor force employed in the industry. Coincident with employing large scale methods wherein greater specialization exists there has been a decline in the need for skilled workers in the industry. In 1940, "craftsmen, foreman, and kindred employment" comprised

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[59]"Why Modern Airplanes Cost So Much," U.S. News and World Report, 33 (July 27, 1956), 112.

[60]It was estimated for 1956, for example, that direct production labor manhours per airframe pound were only fifty per cent of what they were during World War II. Ibid., p. 113.

42 per cent of the labor force in the industry.[61] By 1954, this class represented only 27 per cent of the workers in the industry. Unskilled workers, "operatives and kindred workers," which were 30 per cent of those employed in the industry in 1940, increased to 37 per cent of the total by 1954. Because of the complexity of the aircraft produced in 1954 in comparison with that of 1940, "professional, semi-professional, and technical" workers had increased from nine per cent to 15 per cent of total aircraft employment.[62]

In summary, the decisions of the Government to give sizable orders for aircraft to a small number of producers has resulted in concentration of production in the airframe industry. Because concentration existed, producing firms have been able to adopt large scale production techniques with greater utilization of capital. As a consequence of this technology, economies of scale have resulted reducing per unit costs of aircraft production. A consequence of large scale production techniques and the more complex nature of aircraft produced has been the changed composition of aircraft employment to more unskilled and more technical workers.

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[61] Kupinsky, op. cit., pp. 1324-1325.

[62] Ibid.

CHAPTER IV

THE CHARACTER OF COMPETITION

Structure of the Market

Supply side of the market.--There are a small number of producers of the products of the aircraft industry. If the market for aircraft is analyzed in terms of its several sectors, i.e., military, commercial transport, and utility aircraft production, suppliers in the respective sectors are much smaller in number and concentration of output among producers is much more pronounced than when viewed from the standpoint of number of producers in the entire industry. Because of the fewness of important producers in each of the market sectors and the differentiated nature of the products of each producer, it has been stated that the structure of the supply side of the market in each of these market sectors is that of a differentiated oligopoly.

Demand side of the market.--With respect to the demand side of the market in the three market subdivisions, the market structure is different in each case. In the military market, although the independent services procure in accordance with their own separate needs, the Department of Defense is the sole purchaser of the products of the industry. Hence, the demand side of the market for the military

products is monopsonistic in structure. In the commercial transport market there is a relatively small number of important buyers, namely the air transport companies. The demand side of the market for commercial transport production is therefore oligopsonistic in structure. The output of utility aircraft is purchased by buyers who number in the thousands. Except for the Government's role as a utility aircraft purchaser, the structure of the demand side of the utility aircraft market is such that buyers cannot exert appreciable bargaining power over sellers.[1]

In analyzing the behavior of the aircraft industry and the competitive practices in which it engages, it is essential to first have an understanding of how the aircraft market is organized. As will be demonstrated, market structure conditions behavior within the industry and helps to explain why firms in the airframe industry engage in the forms of competition which they do. The concern of this chapter is with the types of competition in which firms in the airframe industry engage, and how these competitive practices have been conditioned by the structure of the market.

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[1]The above is a summation of principal conclusions of the two previous chapters, the first of which deals specifically with the structure of the demand side of the market for aircraft, and the second with the structure of the supply side of the aircraft market.

Competitive Practices

Design competition in the military market.--The Government as a monopsonist in the military market for the products of the airframe industry dictates the products it wants produced and how much it wants produced. The Air Force and the Navy, after new mission requirements have been established, submit specifications concerning the type of aircraft they want produced, with respect to performance characteristics, to companies which they consider qualified to produce such aircraft.[2] The airframe companies entering the competition then each attempt to design an aircraft in accordance with the Government specifications which is theoretically capable of certain performance characteristics. For example, the Air Force invited Boeing, Convair, North American, and Martin to submit design proposals on the production of what became known as the B-47 medium jet bomber.[3] Each firm attempts to submit a design which appears most capable of performance with respect to the specifications laid down. This type of competition is known as "design competition." It is the most intense and important type of competition in which firms in the industry engage. The Government, in the interests of national security, is more concerned with the quality of the products to be

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[2]U.S. Congress, Aircraft Production Costs and Profits, pp. 1762 and 2829.

[3]Ibid., p. 2829.

purchased, than in any other single feature. Below is an account of a discussion between Mr. J. L. Atwood, President of North American Aviation, and Mr. William H. Bates, Congressman from Massachusetts, which helps to illustrate this point.

Mr. Bates. Let's talk about competition. Yours is not a question of competition for price on production.

Mr. Atwood. Not directly.

Mr. Bates. Because you said you progressed 20 per cent of the way before you ever determined what the price is going to be. So your competition is more in design.

Mr. Atwood. It is technical and design competition; yes, sir. That is the emphasis.

Mr. Bates. That is right. Once you have designed the F-86, that was your baby. And future contracts would go to you?

Mr. Atwood. Yes, sir.

Mr. Bates. So you get a different form of competition.

Mr. Atwood. It is.

Mr. Bates. Than you ordinarily have in most business. That is the reason you advertise for more engineers. You want to get the very best, and the reason you have incentive-contract negotiations.

Mr. Atwood. Yes, sir.

Mr. Bates. So we get an altogether different situation than we got in most business, then?

Mr. Atwood. We do. Of course price of an airplane does have a direct effect, too. When two generally comparable planes could be made available, the cheapest plane would be bought.

Mr. Bates. Yes. But how often does that situation ever arise?

Mr. Atwood. Not very frequently. From time to time it does.

Mr. Bates. What they [the services] want is performance.

Mr. Atwood. Yes, sir.[4]

The primary importance of aircraft design with the desired performance capabilities is generally agreed upon by the purchasing agents of the Government as well as the members of the industry.[5] As expressed by General D. H. Baker, Director of Procurement and Production, Air Materiel Command of the Air Force, when referring to procurement: "Performance is our number one objective."[6]

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[4] Ibid., p. 1373.

[5] That performance is usually a more important factor than cost or numbers of aircraft is brought out by this statement made by General Nathan F. Twining, Chief of Staff, United States Air Force, in February of 1955: "As our technology improves, our strength tends to become more dependent on quality. A thousand interceptors that could not fly as high as an enemy bomber would not be as good as one that could fly higher.

"Our most important job is to keep our Air Force planes and equipment superior to the Soviets." Aircraft Industries Association, Plane Views (Washington: Aircraft Industries Association of America, 1956), p. 22.

For other statements concerning the prime importance of design, see also the testimony of Mr. Clyde Skeen, Company Controller, Boeing Aircraft Company, U.S. Congress, Aircraft Production Costs and Profits, p. 1762; the testimony of Mr. Raymond H. Fogler, Assistant Secretary of the Navy for Materiel, ibid., p. 2729; and the testimony of Mr. Dudley C. Sharp, Assistant Secretary of the Air Force, Materiel, ibid., p. 2829.

[6] Ibid., p. 2829.

Design competition is especially intense because the company which wins the competition is usually the one which gets the production contract to produce the aircraft, as was brought out in Mr. Atwood's testimony.[7] This assumes, of course, that the prototype developed following the winning of the development contract[8] is successful. It is from the award of the production contract that the firms expect to make profits. As examples, by winning the design competition and developing a successful prototype of the F-86, North American received ten follow-on contracts for this aircraft. Fairchild received six follow-on contracts for its winning the design competition of the C-119. Boeing was the recipient of four follow-on contracts for the B-52 by March, 1956. In sum, as Mr. J. L. Atwood of North American Aviation has stated: "A winning design is the ticket of admission to

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[7]That the winning of a design competition, followed by the development of a successful prototype, places a firm in the position for the production contract is revealed further by the discussion of Mr. C. P. Nelson, Congressman from Maine, and Mr. William M. Allen, President of Boeing Airplane Company:

> Mr. Nelson. Isn't it true that once you develop a prototype like . . . the B-52 and win the competition, that you have a practical monopoly on that particular field of aircraft?
>
> Mr. Allen. Certainly no one else is building B-52's. But there are competitive aircraft coming along. And it is up to us to keep the B-52 the best bomber as long as we can.

(Ibid., p. 1879.)

[8]Development contracts are usually awarded by the Government on a "cost-plus-fixed-fee" basis because of the uncertainties of costs incurred in the performance of such work.

the production show."[9] It is in the "production show" that the firms have the biggest opportunity to make profits.

Price competition in the military market.--At the same time design proposals are being considered, price competition plays an important part in the determination of who will get the development and production contracts. Preliminary cost proposals are submitted with designs.[10] Guiding factors, other than design capabilities, in determining which proposed aircraft will be chosen by the Air Force selection board are the cost histories of the competing companies because if the production costs of a company are relatively low there will be more opportunity afforded to negotiate a lower price on the production contract. Price ranks equally as high as a governing consideration in Navy procurement. The first fundamental objective of the Navy's procurement policy is ". . . to obtain the best aircraft at the lowest overall cost to the Government."[11] It would appear that there are at least two prices of each company which the Government evaluates. The first is the preliminary price on the production of the proposed aircraft design. The second is the historical price reflecting manufacturing

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[9]Lambeth, op. cit., p. 34.

[10]U.S. Congress, Aircraft Production Costs and Profits, p. 1762.

[11]Ibid., p. 2728.

efficiency in past aircraft production.

Cost projections of aircraft production are necessary before a manufacturer can arrive at a price proposal. One of the most important standards used by the industry for this purpose is the "learning" or "improvement" curve. This curve, empirically derived, forecasts that the time required to perform a task will decrease each time the task is repeated, and that the decrease in time required will be less with each marginal unit of output. By way of example, on an 80 per cent learning curve, if 1,000 man hours are required to produce the first unit, the second unit will require 800 man hours, the fourth, 640 man hours, and so on. The 80 percent learning curve was regarded as the norm in the industry on the basis of World War II experience. More recent experience, however, indicates that major aircraft companies are now operating more efficiently.[12]

Figure 8 is an illustration of an 80 percent learning curve indicating man hours required for successive units of production. This standard is a basic tool, used along with cost estimates mainly of materials, overhead, and subcontracting, in forecasting costs for contract proposals by aircraft manufacturers.[13] On the basis of projected costs

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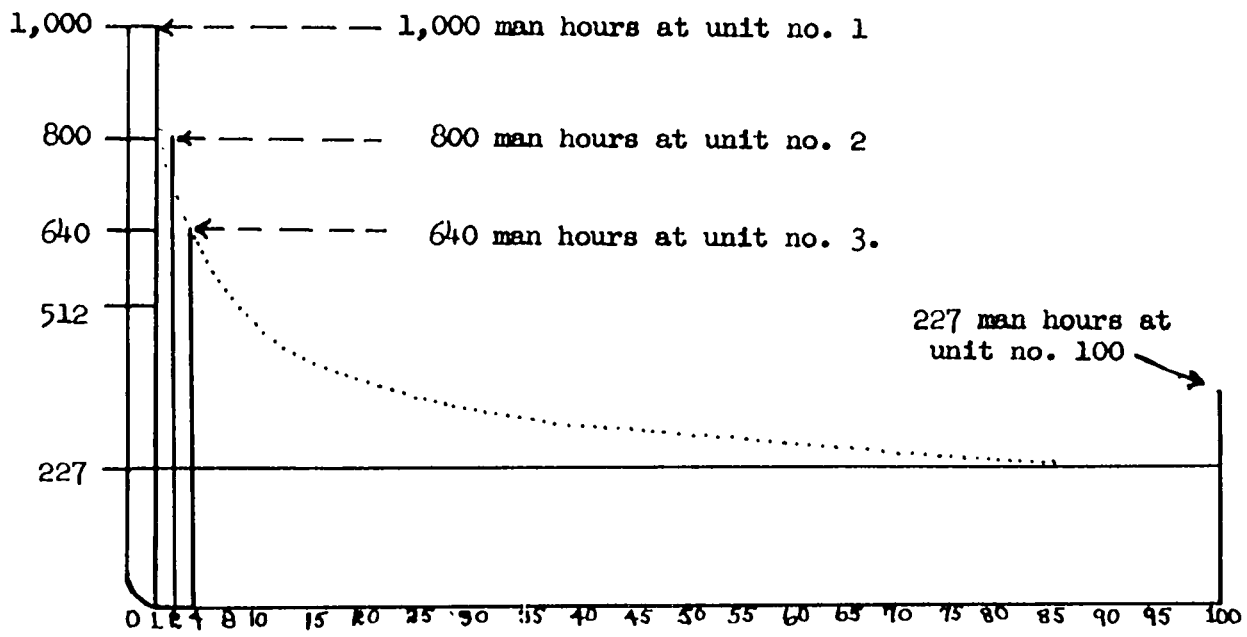
[12] Ibid., p. 1766.

[13] It is also used in conjunction with developing labor loads, determining area and equipment requirements, determining shop efficiency requirements, measuring progress on active contracts, and has a variety of other applications. (Ibid.)

FIGURE 8

"LEARNING" OR "IMPROVEMENT" CURVE
(80 percent curve)



Source: U.S. Congress, Aircraft Production Costs and Profits, 1956.

of production, manufacturers arrive at their preliminary price proposals which they present in competition with one another. The services also estimate production costs when design proposals are submitted and also use learning curves in conjunction with other cost estimates in examining price proposals of the competing companies.[14] The services use the learning curve as a measure of efficiency and production capability and to analyze the manufacturers' bids for accuracy and reasonableness.[15]

But price competition by aircraft manufacturers is largely a case of offering evidence of ability to produce at low costs because the Government attempts to allow a narrow range of profits on all contracts. Target profit of the Navy on contracts is 7 to 10 percent of production costs; target profit of the Air Force on contracts is 7 to 9 percent of production costs.[16] Therefore, price competition of firms is tantamount to production cost competition because Government policy specifies that allowable target prices are only those which include costs plus between 7 and 10 percent of costs. The price competition then becomes one of seeing which firm can produce the most efficiently. It is hard to find other evidences of price competition in

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[14] Ibid., p. 2822. According to Colonel George W. Thompson, Chief of the Pricing Staff Division of Air Materiel Command: "Learners curves are used in all types of negotiation." (Ibid., p. 2840.)

[15] Ibid., p. 1766. [16] Ibid., p. 2844.

the airframe industry because aircraft (design proposals) vary so widely as to their capabilities and production costs that it is not simply a matter for the Government to choose the lowest priced of several comparable aircraft.[17] The Government as a monopsonist is in such a strong bargaining position that, after deciding which aircraft is to be produced, it practically sets the price at which it will buy. As Colonel George W. Thompson, Chief of Pricing Staff Division, Air Materiel Command, stated concerning pricing:

> But this whole price objective is worked out by this Government team and reviewed prior to going into negotiations with the contractor. Then discussions are entered into with the contractor. They are more or less of a fact-finding nature, comparing facts that we have as to cost projections or cost experience, with what data the contractor uses to support his proposal.[18]

In other words, after deciding on the aircraft which the Air Force wants produced, the Government decides the price it will pay. Then it enters into negotiation with the firm, mostly to check its data upon which the price was based, against that of the firm.[19] Such negotiations require on an

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[17]See the discussion of this point by Congressman William H. Bates and Mr. J. L. Atwood, President of North American Aviation, supra.

[18]U.S. Congress, Aircraft Production Costs and Profits, p. 2848.

[19]Government procurement regulations and instructions set forth certain major considerations to be evaluated by the procurement representatives of the Government during the contract negotiation before deciding what the target price and profit will be. Below is a list of these considerations:

1. Quality of product
2. Relative complexity of the product

average from one and a half to two weeks to complete.[20]

Other forms of competition.--Firms compete with one another for Government contracts in ways other than by design and price. Demonstrated production ability is an important consideration determining to whom a contract should be awarded. Actually this is taken into consideration before the Government invites firms to enter the design competition. Also important is the reputation of the firm in meeting its agreed upon delivery dates according to schedule.[21] In any new competition opened by the Government firms compete actively with one another by proposing as early delivery dates on production as possible.

The principal ways in which firms compete have been summarized by Mr. Cyril Chappellet, Senior Vice President of

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3. Reasonableness and reliability of past prices and estimates (of the company)
4. Record of efficiency and economy of contractor
5. Ability of contractor to meet required delivery schedules
6. Need for the product or service
7. Amount and quality of subcontracting
8. Degree of risk which contractor assumes
9. Extent of Government financing
10. Capital investment of the contractor
11. Extent of Government-furnished production facilities
12. The current and anticipated volume of business
13. Unusual services furnished by contractor.

See testimony of Mr. Clyde Skeen; ibid., p. 1768.

[20] Ibid., p. 2849.

[21] In 1953 Secretary of Defense Charles Wilson stressed the importance of meeting delivery schedules when he announced that manufacturers who failed to meet delivery schedules would have their aircraft dropped from the defense program. [R. Hotz, "Defense Sets New Rules for Plane Buying," Aviation Week, 58 (June 8, 1953), 14.]

Lockheed Aircraft Corporation:

> To be successful, Lockheed or any other company must keep coming up with new designs and improvements to attract customer interest. We must sell them at a competitive price. And once we get an order, we must keep our costs within limits of the contract price we have quoted and deliver on time.[22]

These factors--excellence of design, price, and delivery dates, assuming demonstrated production ability, are the principal considerations in determining which firm will win a competition. For any particular competition, each may have a different weight depending on the mission of the service and its procurement requirements.[23]

Types of contracts.--Since 1950 there have been two principal types of Government contracts used in the aircraft industry.[24] The cost-plus-fixed-fee type has been used for development work where there is not well established

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[22]Cyril Chappellet, "How to Sell Airplanes," The Lockheed Story, February, 1955, p. 1.

[23]U.S. Congress, Aircraft Production Costs and Profits, p. 1762. Competition in design, price, and delivery dates--and usually in that order of importance--are considered to be the principal ways in which firms in the industry compete once firms have been selected to enter a competition. These views also have been expressed by other representatives of the industry in interviews with the author: author's interview with Mr. F. A. W. Stiefler, Aircraft Industries Association, Los Angeles, California, July 10, 1958; author's interview with Mr. Don Black, Douglas Aircraft Company, Santa Monica, California, July 8, 1958; author's interview with Mr. R. S. Johnson, North American Aviation, Inc., Los Angeles, California, July 9, 1958; author's interview with Mr. Ernest A. Foster, Lockheed Aircraft Corporation, Burbank, California, July 8, 1958.

[24]U.S. Congress, Aircraft Production Costs and Profits, p. 1762.

cost and production experience upon which to base a price. The incentive-fixed-price type includes an agreed upon target price and a ceiling price. If the contractor's production costs are less than the target costs, the savings are divided between the Government and the contractor. If the final costs exceed the target price, the contractor loses a percentage of his target profits; but if costs exceed the ceiling he suffers a loss.[25] The incentive contract usually provides that if savings are realized, the Government gets the larger share of the additional costs and the company the remainder.[26] Follow-on incentive contracts may split savings on a 95-5 percent basis with the 95 percent going to the Government. Later contracts for the same aircraft may split savings on as much as a 70-30 percent basis, with the 70 percent going to the Government. The more generous terms are provided because as the company gets farther down its learning curve production costs become more difficult to reduce. The larger bonus provides a bigger incentive to

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[25]For a discussion of this and other types of Government contracts with the industry, see Day, op. cit., pp. 75-115.

[26]In Boeing's experience it has had incentive contracts stipulating that the Government was to receive 80 percent of any savings realized and would pay 80 percent of costs in excess of target costs below ceiling price. (U.S. Congress, Aircraft Production Costs and Profits, p. 1762.) But over the period 1950 through September 30, 1955, Boeing underran target costs around 6 percent, which amounted to more than $141,000,000. This was a savings to the Government of around $113,000,000 in contract sales price reductions. Boeing's share of the $141,000,000 cost savings was $38,000,000, or somewhat under 27 percent of the cost savings. (Ibid., p. 1778.)

lower costs under the more difficult conditions.[27]

The aircraft firm in the oligopolistic arrangement is more or less compelled to accept the contract terms of the Government. For if the firm attempts to drive too hard a bargain, the Government can give the production contract using the same design to one of the other competitors. The loss by the Government incurred in doing this perhaps would not be too great, if there were one, because all the top present-day producers have long experience and recognized ability in aircraft production.

After a model is placed in production price competition from other firms in follow-on procurement becomes virtually impossible. This is because the initial prime contractor has already accomplished the basic engineering and tooling and has charged off these costs against the original contract, giving him a distinct cost advantage. Further, the initial prime contractor can now produce on a lower position on his learning curve, which lowers total costs even further by reducing recurring production costs.[28]

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[27]See Clarence S. Irvine, "USAF Contracts Spur Cost Reduction," Planes, 13 (March 27, 1957), 1.

[28]See testimony of Mr. Clyde Skeen, U.S. Congress, Aircraft Production Costs and Profits, p. 1762. Even under these circumstances a firm cannot afford to become inefficient even if its price under inefficient operation would be lower than that any other producer could afford to charge. In order to get future Government business, a firm must continually demonstrate its ability to operate efficiently. W. E. Beall, "Low-Down on Aircraft Industry," Commercial and Financial Chronicle, 184 (November 1, 1956), 1874.

This explains why follow-on contracts usually go to the initial prime producer.[29]

After the initial production contract is granted, the most active form of price competition which does take place in the industry is between firms for subcontracts from prime producers and the Government for aircraft modifications, parts manufacturing, and services. This is especially true of the large producers when they do not have a large enough backlog to keep their facilities and personnel fully occupied on prime contracts.[30] Here price is of extreme importance as well as delivery dates. Design is no longer a competitive matter because work is accomplished in accordance with the prime's specifications.

Consequent forms of competitive behavior.--Because the broad mission of the flying services is to maintain air supremacy, aircraft design is of paramount importance in determining which companies are recipients of Government contracts. To bring about advances in design and to achieve technical leadership in the industry, costly research and

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[29]There are exceptions to this but the exceptions generally have taken place during unusual circumstances. During World War II it was a general practice of contractors to produce aircraft of someone else's design. During the Korean War, Kaiser was producing the C 119 as part of the Government's policy to provide for an expanded industrial base. Also at that time, Lockheed and Douglas were producing Boeing's B-47 to increase its rate of output in the emergency. For the same reason General Motors was producing Republic's F-84.

[30]Author's interview with Mr. R. S. Johnson, loc. cit.

development are required.[31] In 1953, which is the most recent year for which complete statistics are available, the aircraft industry spent $758,000,000 of its own money on research and development projects.[32] This was equivalent to 12 percent of the aircraft industry's sales dollar that year.[33] By 1957 it was calculated that the aircraft industry was ploughing back 13 percent of its sales dollar into research and development.[34] This represented the highest ratio of any United States industry.[35] Technological advances have come about so rapidly since World War II that any company which did not maintain a forward-looking, well-financed research and development program would soon find itself without Government contracts.[36] As a whole, the aircraft industry plows back between 60 and 70 percent of its net profit after taxes into its operations.[37] Technological competition within the industry is so keen that

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[31]See Lambeth, op. cit., p. 34.

[32]Aircraft Industries Association, Plane Views, p. 74.

[33]Ibid.

[34]R. Hotz, "Research Is Lifeblood of Aviation," Aviation Week, 66 (June 3, 1957), 70.

[35]Ibid.

[36]"Air Superiority Formula: Cooperation," Planes, 13 (February 27, 1957), 7.

[37]U.S. Congress, House of Representatives, Report on Aircraft Production Costs and Profits, Subcommittee for Special Investigations of the Committee on Armed Services, Under authority of H. Res. 112, 84th Cong., 2d Sess. (Washington: Government Printing Office, 1956), p. 3114.

without such a high reinvestment rate, a company's opportunities for new business would largely be lost.[38]

As examples of how the race for technological superiority has affected leading companies, Fairchild increased its expenditures attributable to research and development each year since 1952 through 1957 from $829,000 to $7,487,213.[39] For Lockheed the rise in expenditures on research and development was even more phenomenal. Since 1952 expenditures for this purpose rose from $887,000 to $25,670,000 in 1957.[40] Douglas had experimental costs of

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[38] Ibid. The policy of the Government with regard to its financing of research and development has been to confine such facility investment to projects which it judges too costly for firms in the industry to build or operate. Several examples of these are the National Advisory Committee for Aeronautics installations at Langley, the Lewis and Lewis Laboratories, and the USAF Missile Test Center at Cape Canaveral. (See Hotz, op. cit., p. 71.) Government sponsored research and development programs for national security greatly outweigh those of private enterprise and they will have increased tremendously between 1955 and 1959. Department of Defense funds programmed for strictly research and development were $1,349,600,000 in 1955. In 1959 it is estimated they will be $2,588,100,000. (Aircraft Industries Association, Aviation Facts and Figures, 1958, p. 45.)

In 1955 the research and development activities financed by the federal Government amounted to more than one-half the research and development activities in the country. Eighty-five percent of this federal activity was for national security purposes. ["USAF Urges Aircraft Industry to Use Own Funds for Research," Aviation Week, 63 (September 5, 1955), 14.] The research and development projects of the Air Force are administered by the Air Research and Development Command. ["ARDC," Aviation Week, 66 (June 3, 1957), 93.]

[39] U.S. Congress, Aircraft Production Costs and Profits, p. 2001; and Fairchild Engine and Airplane Corporation, Annual Report 1957 (Hagerstown: Fairchild Engine and Airplane Corp., 1957), p. 16.

[40] Lockheed Aircraft Corporation, 26th Annual Report (Burbank: Lockheed Aircraft Corp., 1957), pp. 10, 20.

$54,669,390 in 1957, which was more than double the amount of 1956.[41] For the seven year period through 1955 Republic had profits after taxes of $46,123,000. Of that amount, 37 percent was invested in facilities, 23 percent was paid out in cash dividends and 40 percent was otherwise retained in the business.[42] Between 1956 and 1958, Boeing expected to spend $73,500,000 on new plant and facilities.[43] The large expenditures on research and development and on the new facilities necessitated for it, as well as on the new facilities needed to produce the changing products,[44] has been a consequence of the emphasis in competition on the quality of design. In 1951, the Bureau of Labor Statistics reported that research and development expenses of the aircraft industry were 12.7 percent of sales as against 1.2

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[41] Much of this was attributable to the heavy cost of development of the DC-8. Douglas Aircraft Company, Annual Report 1957 (Santa Monica: Douglas Aircraft Co., 1957), pp. 3, 37.

[42] U.S. Congress, Aircraft Production Costs and Profits, p. 2370.

[43] Ibid., p. 1809.

[44] It is believed that facilities investment would take place at a higher annual rate than it does if it were not for the depreciation policy of the Government. On an average the industry must depreciate its tools over a 12 year period, but much of the equipment becomes obsolete in less time. This is attributable to the rapid technological change in aircraft and materials used in their construction. If facilities could be depreciated at the rate of obsolescence, then the less efficient outmoded World War II tools of the Government would be utilized to a lesser extent and investment in new facilities would be larger. [See R. T. Hurley, "Depreciation Policy Drag on Aircraft," Iron Age, 173 (April 29, 1954), 75.]

percent for the motor vehicle industry, 3.0 percent for the chemical industry, and 6.4 percent for the electrical equipment industry.[45] Such is an indication of the relative emphasis on research and development which, it is maintained, is a consequence of the importance of design competition in the aircraft industry.

Design competition and competition to reduce costs, and hence price, have resulted in extensive use of scientific and technical personnel in the industry. Not only does the aircraft industry spend more money on research and development than any other segment of the United States' industrial structure, but it also employs approximately 25 percent of all research and development personnel working in all industries.[46] In January of 1952, 20,000 of the 90,000 professional research engineers and scientists in the United States were employed in the aircraft industry.[47] Out of 220,000 total of research personnel employed in American industry that year, 50,000 were employed in the aircraft industry.[48] This phenomenon appears to be a growing trend in the industry. For example, in 1943 one out of 22 Lockheed employees worked in the engineering departments. By 1951 the proportion was one out of eight, and in 1957 one

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[45] U.S. Congress, Aircraft Production Costs and Profits, p. 2583.

[46] Aircraft Industries Association, Plane Views, p. 52.

[47] U.S. Congress, Aircraft Production Costs and Profits, p. 2583.

[48] Ibid.

out of five Lockheed employees worked on scientific or engineering projects.[49] At Convair, 20,000 out of the 70,000 employees are in engineering and 10,000 of them have college degrees.[50] At Chance Vougt, of the 2,200 employees in engineering, 1,500 have engineering degrees.[51] Convair employs as consultants such top scientific leaders as Dr. Edward Teller, Dr. Hans Bethe, Dr. Edward Creutz, Dr. Frederic De Hoffman, and Dr. Charles Crutchfield, to mention some of the more outstanding.[52] This illustrates the extent to which the industry is forced to concentrate its activities in engineering and scientific research as an outgrowth of the emphasis of competition in design and cost reduction.

Because of the necessity for such skills in the industry there is aggressive competition in the factor market between firms for personnel with scientific and engineering training and experience.[53] The growing demand for personnel with such technical abilities coupled with the existing short supply of such highly trained personnel[54] has been important in accounting for the rise in salaries and wages in the

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[49]Lockheed Aircraft Corporation, op. cit., p. 10.

[50]U.S. Congress, Aircraft Production Costs and Profits, p. 2591.

[51]Ibid., p. 2460. [52]Ibid., p. 2590.

[53]See testimony of Mr. J. V. Naish of Convair; ibid., p. 2570.

[54]Lee, Aviation Facts and Figures 1958, p. 53.

industry in recent years.[55] Such circumstances have played an important role in causing aircraft industry employee wages to be among the highest weekly wages of all manufacturing employees.[56] Firms conduct intensive advertising campaigns to attract highly qualified personnel. As the President of General Dynamics Corporation, Mr. John J. Hopkins, expressed:

> . . . You see every day, or certainly every weekend, if you pick up the New York Times, page after page of these great big advertisements, trying to intrigue--and we are competing against each other, unfortunately. They are trying to intrigue these men that have competence and brains. We find it very difficult to keep these staffs built up.[57]

Competition in the factor market for technically qualified personnel whose services are sought ultimately to produce winning aircraft designs and to enhance production efficiency is another form of intra-industry competition.[58] It can be viewed, however, as a consequence of the primary forms of competition in the industry.

In relation to the hiring of qualified personnel, it should be noted that companies actively seek to employ influential retired military officers. Personnel with such

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[55] Between 1952 and February of 1958 average hourly earnings in the airframe industry rose from $1.87 to $2.43. (Ibid., p. 60.)

[56] Ibid., p. 54.

[57] U.S. Congress, Aircraft Production Costs and Profits, p. 2591.

[58] It is not the intention herein to analyze the factor market but only to emphasize that firms in the industry compete actively in it for the skills necessary to help win Government contracts.

backgrounds are valuable because of their extensive experience in matters allied to the aircraft industry. Motives for hiring retired key military personnel, "fresh from the other side of the desk," could also include making use of service connections to win Government contracts. In 1956 Lockheed had 18 retired officers on its payroll, Convair had 67, Boeing also had 67, and Martin had 14, to mention several of the companies.[59] An outstanding case was the hiring of General Joseph McNarney by Convair upon his retirement. He was appointed president of that organization at a yearly salary of $75,000 plus a $25,000 annual bonus and was given a consultant contract for ten years at $30,000 per year.[60] Personnel with such military experience evidently are of much value to firms manufacturing weapons of defense and doing business with the Government.

Advertising, a widely used method of competition for demand creation among most differentiated oligopolies, is not used to a significant extent in the military airframe industry. As Mr. F. O. Detweiler, President of Chance Vought, remarked concerning the nature of advertising in the industry:

> This advertising is essentially in the form of an institutional type of advertising and is not to influence

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[59] "Aircraft Lobby," Nation, 185 (July 20, 1957), 22; and U.S. Congress, Aircraft Production Costs and Profits, p. 2528.

[60] "Aircraft Lobby," loc. cit.

> sales but more to present the company and its products. There are two things involved. One is the attraction of highly technical, highly skilled technical personnel. It is also we think, a substantial contribution to the military air corps interest.[61]

In Chance Vought's case, "selling and service expenses" amounted to forty-eight one-hundredths of one percent of total sales. Of this fraction, advertising was 33.77 percent.[62] Because the military airframe industry sells only to one customer, the Government, which employs experts to do its buying, advertising plays a relatively unimportant role as a method of competition within the industry.

Illustration of industry revenue and cost conditions.--The military airframe industry represents an unusual study in market behavior. On the basis of learning curves and cost data, the evidence suggests that average costs continue to fall with increases in output. This implies an average cost curve which is everywhere downward shifting in time and probably downward sloping at any point in time. In Figure 9, curves "a" through "f" represent shifting average costs in the short run which would correspond to different points along a downward sloping learning curve. The downward slope of each of the average cost curves relates to the economies of scale of operation. The "Average Cost Curve" connects

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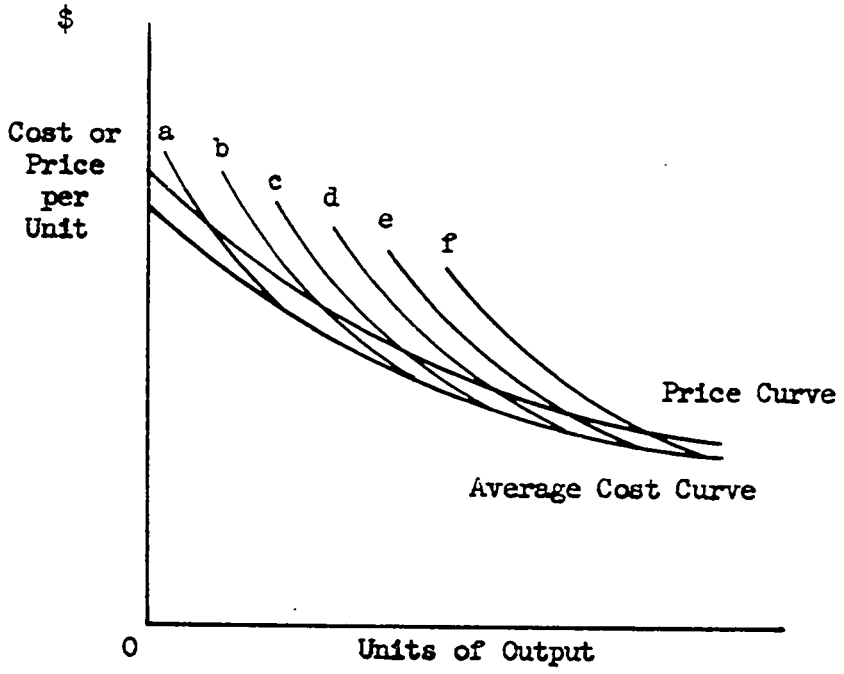
[61] U.S. Congress, Aircraft Production Costs and Profits, p. 2486.

[62] Ibid., p. 2487.

FIGURE 9

RELATION OF PRICES AND COSTS IN MILITARY AIRFRAME MANUFACTURING[a]



[a]Note that the Average Cost Curve and Price Curve are drawn so that profit is eight percent of average cost per unit of output.

the various points of operation along the shifting average cost curves "a" through "f."

In economic analysis the demand and cost curves of an industry are considered to be quite independent as to their determinants. As in all cases of monopsony and bilateral monopoly, the price received by the seller is related to the demand curve only indirectly. The price received by the seller in such cases falls along the seller's offer curve. This is true of military airframe production. The price curve for the military airframe industry appears as a function of the average cost curve because prices paid for the industry's products are determined on the basis of production costs. Figure 9 is an illustration of the relation between the industry's price curve and its average cost curve at various outputs. It shows the highest price the Government will pay per unit of output at different quantities which the Government may contract to buy. The most profitable point of operation under these market conditions is always the point where total costs are the largest because profits are allowed as a given percent of costs. Prices always reflect about the same percent of profits based on production costs. It is not the prerogative of the firms to choose the most profitable point of operation. Rather, because aircraft manufacturing is essentially a contracting industry selling to the Government, the firms produce the quantity the monopsonistic Government contracts to buy.

The commercial transport market.--In many respects

the competitive behavior of producers in the commercial transport market resembles that of military producers. The market differs in structure, however, in that there are fewer producers and more buyers. The market structure is that of a bilateral oligopoly.[63] The difference in structure of the market and the nature of the producers demanded accounts in large measure for the difference in market behavior.

The big airlines, when they desire new aircraft, hold design competitions in much the same manner as does the Government for military aircraft. Leading producers judged capable of producing aircraft of the nature being sought are invited to enter the competition.[64] Because the possibility

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[63]At present there are five domestic producers--Douglas, Lockheed, Convair, Boeing and Fairchild, which have products on the market. There are, moreover, foreign producers in the market. British products include the Comet IV pure-jet and the Brittania and Viscount prop-jets. Others include the French Caravelle pure-jet, the German Fokker F-27 prop-jet (which is made also in the United States by Fairchild), the Canadian Canadair Model 550 prop-jet, and Russia's TU-104 pure-jet and TU-114 prop-jet. (Author's telephone conversation with Mr. F. A. W. Stiefler, Aircraft Industries Association, October 7, 1958)

There are 40 domestic airlines although there is considerable concentration among the "Big Four." As of June, 1958, sixteen foreign airlines had ordered Douglas DC-8's, and Boeing 707's. As of October, 1958, there were no outstanding orders for foreign-built transports by domestic airlines, and only Capital Airlines and Continental Air Lines had foreign-built transports in service. (Ibid.)

[64]C. J. W. Murphy, "The Wild Blue Chip Yonder," Fortune, July, 1955, p. 76; and author's interview with Mr. Ernest A. Foster, loc. cit. This is not the practice of the small airlines, presumably because the size of their orders would not justify the production costs coincident with a design change.

of sales runs into the millions, producers are willing to invest their capital in projects calculated to produce a winning design. Particular attention is paid to producing a product which best suits the specifications of the potential customer because satisfying his needs could mean profits without limitations of the nature imposed in government contracts.

Manufacturers also query companies concerning their interests in new type aircraft which they propose building to see if the airlines are sufficiently interested. For example, when Lockheed was initially considering the possibilities of producing the turbo-prop Electra transport, it contacted the airlines several years in advance of its production. By July, 1958, 151 Electras were contracted for sale before a production model was manufactured.[65] In other words, either the manufacturer or the airline with a large enough order may propose a design which the manufacturer will build.

Before a manufacturer will build a commercial aircraft, it must estimate how many it can sell. Douglas never builds a new model without being reasonably assured of the quantity it can sell.[66] In estimating the potential market prior to receiving commitments from airlines, producers consider the extent to which the costs of existing aircraft have been written off.[67] Knowledge of the extent of the

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[65] Ibid.

[66] Author's interview with Mr. Don Black, loc. cit.

[67] Ibid.

market for a new aircraft must be closely ascertained before the decision to go ahead on its development can be made. This is because the research and development and tooling costs in addition to production costs may be too great to justify the building of too few aircraft. For example, before the prototype of the DC-8 had made its maiden test flight Douglas had spent in excess of $250,000,000 in its development and preparation for its manufacture.[68] As of June 2, 1958, there were 138 DC-8's on order valued in excess of $700,000,000.[69] By September, 1958, Lockheed had spent $120,000,000 in its Electra program before a single aircraft had been delivered.[70]

The most important characteristic of the design of commercial transport aircraft was expressed in a talk to engineering personnel at Lockheed by Mr. Carl B. Squier, Vice President of Lockheed Aircraft Corporation: "Design the airplane so the customer can make money with it. If you build him a loser, you'll never sell him another."[71] Payload,

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[68] Press Telegram (Long Beach, California), May 30, 1958, p. A-4.

[69] Douglas Aircraft Company, "Thousands Cheer DC-8 Flight," Airview News, June 2, 1958, p. 1.

[70] Dudley E. Brown, "Unique Features of the Aircraft Industry" (Speech before the Air Force Pricing School, Santa Monica, California, February 28, 1957), Copy on file, Public Relations Office, Lockheed Aircraft Corporation, Burbank, California.

[71] Carl B. Squier (Speech to engineering personnel at Lockheed Aircraft Corporation, date unknown). Copy on file in Public Relations Office, Lockheed Aircraft Corporation, Burbank, California.

economy of operation, speed, and passenger comfort are all characteristics of performance which receive important consideration by airlines when they are shopping for airplanes.

In the 1930's, salesmen used to sell aircraft to airlines much as automobiles are sold to private consumers today. Now, in order to sell an aircraft its capabilities must be examined by "platoons of people." To quote Mr. Squier again:

> An airline prospect will want its engineering staff, its board of directors, its maintenance personnel . . . to take a look at it. You show them drawings, reports, mockups, sketches, photographs, charts.[72]

Unlike the 1930's, today the job of selling aircraft involves teams from the manufacturer and the airlines, 90 percent of whom are engineers.[73] Both buying and selling are done by experts. Experts representing the manufacturer are needed to explain the performance of the aircraft, and experts are needed representing the airline to ascertain the quality of the product in terms of its capabilities.

Even slight degrees of product differentiation may be significant in determining which company gets a production contract. In the case of Douglas's DC-8 and Boeing's 707 intercontinental versions, which are considered almost identical in general performance and appearance, a deciding factor in United Airlines' decision to order 30 DC-8's was

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[72] Ibid.

[73] Author's interview with Mr. Ernest A. Foster, loc. cit.

because it was three inches wider than the 707.[74] When Boeing then increased the width of the 707 by four inches, the previously hesitant American Airlines decided to purchase 30 of the 707's.[75] In order to sell to BOAC, Boeing had to agree to differentiate its product by using British Rolls Royce engines.[76] For such reasons air transport manufacturers are extremely sensitive to the tastes of the airlines and must be in order to win production contracts from them.

Design competition in the commercial transport field necessarily results in other forms of competition. Such are extensive research and development programs and the recruitment of the best scientific and engineering personnel which was elaborated upon in relation to competition in the military market.

A commercial transport airplane represents an investment to an airline. For this reason price is of extreme importance to the purchaser because the higher the price of a given aircraft the lower will be the rate of return on his investment. After calculating anticipated production costs and estimating the extent of the market for a particular model, a manufacturer sets the price at which the aircraft will be sold. Here the bargaining power of the oligopolistic seller is demonstrated in sharp contrast to the passive role

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[74] "The Selling of the 707," Fortune, October, 1957, p. 246.

[75] Ibid.

[76] Ibid., p. 252.

he plays in the military market.[77] Not only does he alone set the administered price at which the aircraft are sold but also he provides in the contract that buyers must agree to pay higher prices under terms of an "escalation clause" covering possible rises in costs of labor and materials.[78] It is not a case of the buyer setting a price based on the seller's production costs as in the monopsonistic military market. Producers set a "base price" on the aircraft they sell. Each buyer will pay the base price and, if he desires other than standard features on the aircraft, he must pay extra. In practice, each airline desires a significantly differentiated aircraft interior.[79] The extent to which he desires the aircraft differentiated will determine how high the final price is above the base price.

It is difficult to state that aircraft producers engage in price competition when the aircraft of the several producers are significantly differentiated in most cases and the price range is wide. Notwithstanding, Lockheed and Douglas both maintain that they engage in decided price competition in the commercial field in the sense that they attempt to keep prices low.[80] There is some evidence of non-

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[77]It should be recalled at this point that there are usually fewer competitors in the commercial transport market than in the military market.

[78]Dudley E. Browne, loc. cit.

[79]Author's interview with Mr. Don Black, loc. cit.; and author's interview with Mr. Ernest A. Foster, loc. cit.

[80]Ibid., and author's interview with Mr. Don Black, loc. cit.

price competition among closely comparable aircraft. In the jet race for the commercial market, both Boeing and Douglas have set their base prices for the 707 and DC-8 respectively, at $5,250,000.[81] How they both could arrive at this same price to the dollar when so many millions of dollars are involved is difficult to understand unless they do not intend to compete in price. It is not that development and tooling costs have been the same because Boeing has had the most past experience in producing multi-jets (for the military). Consequently, Boeing's development and tooling cost is expected to be approximately $185,000,000 prior to delivery of production models.[82] Douglas, which has had long experience in producing commercial transports but little in producing multi-jet aircraft, will have spent $250,000,000 in preparation for producing DC-8's. Both airplanes, however, were judged to be almost identical in appearance and general performance by the United Airlines' technical evaluation team,[83] which may give some though not sufficient basis for their price identity.

The Douglas DC-7C and the Lockheed 1649A both sell in the same price range between $2,000,000 and $2,250,000, depending on the features of differentiation desired by individual airlines.[84] They have approximately the same

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[81] "The Selling of the 707," p. 254.

[82] Ibid. [83] Ibid., p. 133.

[84] Author's telephone conversation with Mr. F. A. W. Stiefler, Aircraft Industries Association, Los Angeles, California, July 24, 1958.

cruising speed, seating capacity, and range, although the 1647A has a 7,000 foot higher service ceiling. In terms of performance and specifications they are somewhat differentiated but have many comparable features. The Douglas DC-6B is in many respects comparable to the Lockheed 1049G, although the Lockheed model will carry five more passengers, cruises at a slightly faster speed, and has an 8,000 foot higher service ceiling. The 1049G sells for approximately $1,750,000 and the DC-6B sells for approximately $1,500,000.[85] As a general rule, producers sell aircraft which are notably differentiated from those of their competitors with respect to performance and aerodynamic qualities, and price variance is notable.[86]

Buyers of commercial transports benefit through lower prices because of Government financing in the development of military aircraft. Much of that which is learned in the development of military aircraft is applicable to commercial transport aircraft. Also, Government orders for military adaptations of commercial transports enable manufacturers to realize economies of scale which can be passed on in lower prices to purchasers of commercial transport aircraft. This view was expressed by Donald Douglas, Jr.:

> As has always been the case, civil transport will, to a large extent, be dependent upon the military programs

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[85] Ibid.

[86] For a detailed description of the specifications and performance characteristics of the aircraft in current production, see National Aviation Education Council, U.S. Aviation Today, 1958 (Washington: National Aviation Education Council, 1958), pp. 38-40 and 65-66.

> for development of engines, and for a measure of assistance in establishing quantity prices for aircraft.[87]

It is also true that the development of commercial transports has resulted in lower prices of military aircraft for the same reasons. As a general rule Douglas and, to a lesser extent, Lockheed have privately financed the development of their commercial aircraft. Military versions of these have been sold to the Government at lower prices than it would pay if it were to cover development costs and be the only purchaser of these aircraft. On the other hand, since the war Boeing has first produced military versions of an aircraft, such as the C-97 and the KC-135, and later made commercial versions of these such as the Stratocruiser and the 707.[88]

Producers also compete in terms of delivery dates. Douglas, despite its reputation as the long-time leader in the commercial transport field, has found this to be an important reason why it has failed to get certain orders. This has been due largely to already crowded production schedules which have not allowed Douglas to promise early enough delivery dates to a customer's satisfaction.[89] Delivery dates

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[87]Donald W. Douglas, Jr., "Trends in Air Transport," Flying, 58 (May, 1956), 63.

[88]Author's interview with Mr. Don Black, loc. cit.; author's interview with Mr. Ernest A. Foster, loc. cit.

[89]Author's interview with Mr. Don Black, loc. cit.

are important to airlines which are in close competition. If one can provide a superior travel service to that of its competitors, it can look forward to increased revenue. For this reason airlines in general were upset with Pan American's decision to be the first to order commercial jets.[90] This meant that in order to compete the other airlines too were going to have to discard many of their conventional prop-driven aircraft for jets. The sooner they did, the less business they would run the risk of losing. Once a contract is made with an air line for this reason it is essential for the manufacturer to deliver on schedule. A manufacturer with a reputation for not making deliveries on time runs the risk of losing future business. As Vice President of Lockheed, Mr. Carl B. Squier, advised Lockheed's engineering personnel in a speech: "Never fall behind schedule in a development program. A lagging program is the prey of every hungry lion in the competitive jungle."[91] To the seller, early delivery dates of a new model aircraft may have important implications for future business. For example, Boeing was aware that if it were the first to enter the commercial jet transport field with early deliveries, airlines which originally bought the Boeing jets would probably make future purchases with Boeing. The reason for this is that airlines attempt to standardize their fleets in order to minimize maintenance costs and spare

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[90]See "Selling the 707," p. 133.

[91]Squier, loc. cit.

parts inventories.[92]

Commercial transport manufacturers follow a practice of price setting which is designed to cover "full costs" plus a markup. The basic price which is set on a particular model of aircraft applies to all commercial customers although customers who purchase large quantities pay lower unit prices.[93] Taking into consideration costs of development, tooling, production, and anticipated number of sales, the basic price is calculated to yield a profit. Aircraft delivered under early contracts therefore are sold at a loss because of heavy development and tooling costs and less efficient operation. If the extent of the market is larger than originally anticipated, profits are considerable. As Mr. Frederic W. Conant, Senior Vice President of Douglas Aircraft Company, expressed:

> The whole profit in the commercial business is when you get just as far as you can by the break-even as you lost before. . . . On the DC-6 we were $35,000,000 in the hole before we started to work out.[94]

Lockheed follows this same pricing practice. Mr. C. S. Cross, President of Lockheed, stated with regard to this aspect of his company's business:

> The commercial airplane business is a somewhat different business. We start out by spending enormous

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[92] "Selling the 707," p. 254.

[93] Author's interview with Mr. Don Black, loc. cit.; author's interview with Mr. Ernest A. Foster, loc. cit.

[94] U.S. Congress, Aircraft Production Costs and Profits, p. 2222.

> sums speculatively for development and in the early stages of any commercial program we frankly deliver the airplanes at a loss.
>
> If we can keep going long enough and sell enough of them and get enough of a run, sooner or later we get down into the black ink.95

The more commercial orders for a particular model a company gets after covering development and tooling costs, the greater will be its profits per unit at the fixed price. Available evidence previously noted suggests that costs per unit continue to decline as output is extended in aircraft manufacturing.

Figure 10 is an illustration of how commercial aircraft manufacturers anticipate profits or losses resulting from this pricing practice. Distance OA represents the heavy fixed costs of development and tooling before production of any aircraft of a new model. The total cost curve rises rapidly at first but increases at a decreasing rate with extended output. This is due to economies resulting from increasing output and the greater efficiency of operation reflected by the lower position on the learning curve. Because the basic price is fixed, total revenue corresponding units of output increase in a straight line relation. At any output short of "D" number of units, total costs exceed total revenue; hence losses are incurred. At an output of "D" number of aircraft the firm is breaking even because total costs equal total revenue. If output exceeds "D"

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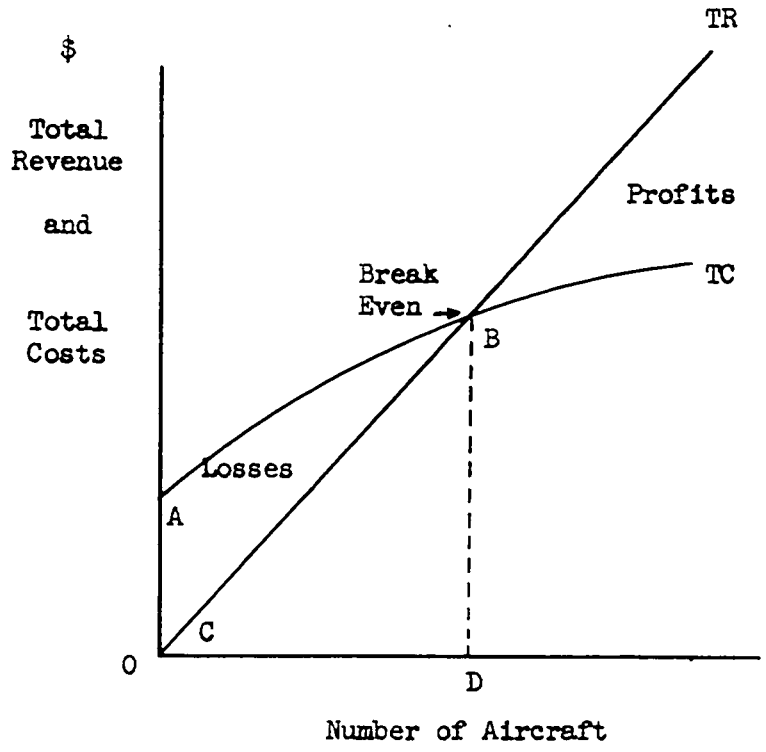
95 Ibid., p. 2534.

FIGURE 10

COMMERCIAL AIRCRAFT MANUFACTURER'S BREAK-EVEN CHART



number of units, then total costs are less than total revenue. The difference between the two will reflect the profits realized on the development and sale of the new model aircraft.

Advertising to increase sales in connection with a manufacturer's commercial operation is not extensive. The advertising that is carried on is of an institutional nature to present the company to the public. This is done to support the airlines which use the manufacturer's products.[96] Extensive advertising is not needed because the number of buyers is small. Further, buying is done by highly specialized personnel who perhaps are less inclined to be influenced by advertising than they are by the technical features of the products which they buy.

Because buyers are few in number, producers cannot afford to be the least bit indifferent to a potential customer. An order from any one of them may run into the millions of dollars.[97] This is especially true in the jet age when a single aircraft may sell in excess of five million dollars. In a speech to a group on how to sell aircraft, Mr. Carl B. Squier, Vice President of Lockheed, gave this advice:

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[96]Author's interview with Mr. Don Black, loc. cit.

[97]Of the commercial transport aircraft being built in 1958, the only model which sold for less than $1,500,000 was the Convair 440 which sold for approximately $750,000. Author's telephone conversation with Mr. F. A. W. Stiefler, loc. cit.

> Never kick a customer in the face--remember we're not running a shoe store. There aren't many airlines in the world, and still fewer air forces. Every one of them is valuable. Not one of them can be replaced. And what memories they have![98]

Competition in the utility aircraft market.--Three producers--Beech, Cessna, and Piper--dominate the personal and business aircraft market. In 1957 they sold almost 90 percent of the output value. The supply side of the market is decidedly oligopolistic but on the demand side buyers number in the thousands.

There is not the strong sensitivity to rivals' behavior in utility aircraft production such as one finds in other oligopolistic industries. This is in large measure attributable to the divisions of the market in which the producers sell. Beech sells fewer aircraft by far than either of the other two producers but its dollar sales were the largest in 1957.[99] Table 26 denotes characteristics of utility aircraft models in production in 1958, and their prices. Beech specializes primarily in producing the twin-engined models. Cessna's two twin-engined models sold in a price range of from $28,000 to $33,000 below Beech's cheapest twin-engined model.[100] Cessna's single engined models are in close competition with those of Piper in terms of

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[98] Squier, loc. cit.

[99] See Table 24, supra.

[100] Price data are not available for Beech's Model 95 Travel Air twin-engined aircraft. On the basis of specifications and performance characteristics the price difference from Cessna's models may not be as great.

TABLE 26

MODELS AND PRICES OF UTILITY AIRCRAFT OF LEADING PRODUCERS, 1958

Models	Number of Seats	Price	Cruising Speed
Beechcraft Super 18 (twin)	8	$106,975	215
Aero Commander 680 Super (twin)	7	89,500	248
Beech E-50 Twin-Bonanza	6	88,000	228
Aero Commander 560E (twin)	7	74,500	210
Cessna L-27A (twin)	4	59,950	210
Cessna 310-B (twin)	5	54,950	213
Piper PA-23 Twin Apache	5	34,950	171
Beech Model 95 Travel Air (twin)	4	N.A.	200
Beechcraft H-35 Bonanza	4	22,650	196
Cessna 182	4	14,350	155
Piper Comanche PA-24	4	13,500	160
Cessna Model 180	4	13,250	160
Cessna 172	4	8,995	124
Piper PA-22 Tri-Pacer	4	7,840	134
Piper PA-18 Super Cub	2	5,700	115

Sources: Airport and Business Flying Directory, 1958; Commercial and Military Aircraft, Cessna Aircraft Company; and U.S. Aviation Today 1958.

price and performance. Of the top three producers it can be said that Beech specializes primarily in producing relatively high and medium priced aircraft; Cessna produces in the upper medium and the low priced field; and Piper produces mostly in the low priced field. Beech has a competitor in terms of performance and price in the fourth ranking producer in the field, Aero Design and Engineering Company. This organization produces two twin-engined models which sell in the high price category. Aero Design has not demonstrated a strong market threat to Beech. In 1957 it produced only 9.8 percent of the value of output in contrast with 33.3 percent for Beech. Also, while sales for Cessna, Piper, and Aero Design declined in 1957 from 1956, Beech's sales rose approximately 12 per cent.[101]

As can be seen from Table 26, the range of prices of utility aircraft is very broad. This is due primarily to the many different qualities of aircraft, in terms of specifications and performance, which are offered on the market.[102] Companies have each sought to appeal to the differing needs of buyers by offering a variety of aircraft to suit the variety of wants. Because of the extent of product differentiation and consequent price differentials, instances of

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[101] See Lee, Aviation Facts and Figures 1958, p. 77.

[102] For a detailed account of the variance of specifications and performance characteristics, see National Aviation Education Council, U.S. Aviation Today 1958, pp. 5, 6, 9, 10, 12, 13, 24, 26-29, 83-85. Also see Airport and Business Flying Directory (New York: McGraw-Hill Publishing Co., 1957), pp. 16-17.

close competition between models of different companies involved seven out of the fifteen airplanes.

In 1931 more flying of light aircraft was for pleasure than for any other purpose.[103] By 1956 more than twice as many hours were flown in utility aircraft for business purposes than for pleasure or any other reason.[104] In 1958 commercial and business flying constituted about 66 percent of the total hours flown by utility aircraft.[105] Because more utility aircraft flying is done for business reasons and the demand for utility aircraft for business purposes is growing the more rapidly, producers have concentrated their efforts in the production of aircraft suitable for these purposes. Producers act more in the interests of creating a new demand for their aircraft than they do by competing in price and producing close substitutes. In effect, their actions bespeak competition with other forms of transport more than among themselves. For example, Cessna provides interesting brochures to its prospective customers which itemize expenses coincident with owning and operating each of its models. The intent is to demonstrate the economy and convenience of utility air transport. Calculating fuel and maintenance, hangar rental, insurance, depreciation, etc., the cost per seat mile to operate the $9,000 Cessna 172 for

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[103] See Lee, Aviation Facts and Figures 1958, p. 83.

[104] Ibid. [105] Ibid.

84,000 miles annually would be approximately $.017.[106] To operate the $55,000 Cessna 310B for 149,100 miles per year the cost per seat mile would be about $.03.[107] Emphasis also is placed on the better utilization of high paid personnel by less time lost in travel. This is made possible by being able to depart for and from business appointments when ready in other areas without having to wait for scheduled departures of the railroads or airlines. Frequently a small aircraft can also land closer to the destination than scheduled airlines or railroads, providing greater convenience and saving additional time. Such points are openly stressed in the attempt to bring new customers into the market.

Selling expenses, which include advertising, have not been as large as a result of the lack of urgency to promote producers' products which are significantly differentiated from those of competitors and between which, in most cases, there are marked price differentials. One study found that selling expenses, based on a sample study, in manufacturing

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[106] Cessna Aircraft Company, Travel and Tax Savings, The Cessna 172 (Wichita: Cessna Aircraft Company, 1957), p. 3. This is even cheaper than inter-city bus and railroad coach transport, which were 2.12 cents and 2.56 cents, respectively, per passenger mile in 1956. (See Lee, Aviation Facts and Figures 1957, p. 99.)

[107] Cessna Aircraft Company, Travel and Tax Savings, Cessna 310B (Wichita: Cessna Aircraft Company, 1957), p. 3. This is more expensive travel than bus or by railroad coach but considerably cheaper than by Pullman and scheduled airlines, which were 4.77 cents and 5.30 cents, respectively, per passenger mile in 1956. (See Lee, Aviation Facts and Figures 1957, p. 99.)

industry averaged 8.9 percent of sales.[108] In 1957 Beech's selling expenses amounted to 4.2 percent of sales; Cessna's were 4.1 percent of sales; and Piper's were 6.5 percent of sales.[109]

Many business organizations which have large annual travel expenditures could reduce transport costs by ownership and operation of business aircraft. Such evidence presented by business aircraft producers may be realistic. If prices on most models were reduced, it is not anticipated that sales would rise significantly. At present aircraft prices, transport costs connected with owning and operating business aircraft perhaps are already notably lower than costs incurred by travel on common carriers. It would seem then that price and operating costs are not the only significant factors in determining purchases of business aircraft.[110]

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[108] Charles A. Bliss, Structure of Manufacturing Production (New York: National Bureau of Economic Research, 1939), p. 89.

[109] For the raw data from which these calculations were derived, see Moody's Investors Service, Moody's Industrial Manual, 1958 (New York: D. F. Shea, 1958), pp. 186, 235, and 349.

[110] A survey conducted of corporate business personnel revealed that 53.4 percent of those sampled believed long distance transport by auto, airline, or rail was safer than private airplane travel. Twenty percent of the firms in the survey responded that the key person in each firm was unwilling to travel by private airplane. National Requirements for Aviation Facilities: 1956-1975, Vol. IV (Washington: Government Printing Office, 1957), pp. 90-91. It appears then that safety and other factors play an important part in determining why organizations which could reduce passenger transport costs and gain other benefits from owning business aircraft do not choose to do so.

About 21 percent of the hours flown by utility aircraft in 1955 were for pleasure.[111] Buyers of aircraft for pleasure purposes are not believed to be very sensitive to changes in aircraft prices because costs coincident with owning and operating pleasure aircraft are considerable.[112] Hence a prospective buyer must consider not only the price of the aircraft but the cost of owning and operating as well. Bollinger's survey revealed that people frequently disposed of their aircraft because over-all costs were too great in relation to the extent of utilization.[113]

Utility aircraft producers, after estimating costs and the number of units which they can sell, set prices designed to yield a target profit. For example, Piper sets its prices at a level designed to yield, after taxes, a net profit of 10 percent of sales.[114] In this case, prices are wholesale prices to dealers, which are usually around 25 percent below retail prices. Both Piper and Cessna believe that a drop in prices on their aircraft would increase the number of aircraft sold but at the expense of decreased profits.[115] On the other hand, each of these producers

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[111] Lee, Aviation Facts and Figures 1958, p. 83.

[112] Bollinger, loc. cit. [113] Ibid.

[114] Answer to questionnaire submitted by author to utility aircraft producers.

[115] Ibid. Neither expressed the view that it would expect retaliatory price reductions by competitors as is the usual practice in oligopoly in order to retain market shares.

considers competitors' products close enough substitutes so that raising prices would reduce sales and profits.[116]

There has been only one instance appearing in the literature where an observation could be made of the impact on sales caused by sharply declining prices of utility aircraft. Aircraft inventories increased tremendously in late 1929 and 1930. In attempts to dispose of the aircraft, producers of these utility aircraft cut prices up to 43 percent below 1929 prices.[117] But the change in sales was negligible.[118] At first glance it would appear that the demand for utility aircraft in the short run in this instance was inelastic. However, because price changes were taking place at the outset of the depression, the lack of responsiveness of sales to reduced prices may not have been due so much to demand inelasticity as it was to a reduction in demand.[119]

Based on the over-all reasons presented, however, it is believed that the demand for utility aircraft for personal and business purposes has a low price elasticity.

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[116] Ibid.

[117] Glover et al., op. cit., pp. 850-51.

[118] Ibid.

[119] That is, the demand curve was shifting to the left because of reduced income and uncertainty of the future.

Barriers to New Competition

Entry of new airframe manufacturers into the industry would probably mean more competition for the existing producers. In airframe manufacturing barriers to entry are almost insurmountable. There was not a major producer in 1958 which had entered the business since 1939.[120] The important barriers to entry in airframe manufacturing are the subject of the discussion which follows.

Patents.--One of the most frequently regarded monopoly advantages is patents. In regard to the aircraft industry, patents are mentioned not because they represent an obstacle to competition but because they do not. This is somewhat unusual.

During World War I production was being held up because of litigation over patent infringements. The urgency of the situation demanded that some arrangement be made to avoid such difficulties. The outgrowth of the situation was the organization of the Manufacturers Aircraft Association. Since 1917, the MAA has administered patent cross-license agreements and licensed contracts under which the aircraft industry has operated. Any member of the MAA (and any aircraft producer may become a member) is privileged to produce

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[120]This encompasses all three market sectors--military, commercial transport, and utility. All of the 12 producers which dominate the military market, all of the commercial transport producers, and the top three utility aircraft producers who accounted for 89 percent of output value in this market in 1957, were in the business prior to 1940. See Moody's Investor's Service, op. cit., for dates of incorporation of leading aircraft manufacturers noted in Chapter Three.

items patented by members of the association. Members submit their patents to the MAA, which evaluates them and determines their worth and what the company should receive when the patent is used by others. These awards have been very small.[121] Over 90 percent of these patents are licensed to other producers without fee, while on others small royalties per plane are paid.[122] The contract relationship between the MAA and the Government has enabled the Defense Department to obtain licenses for production of aircraft or parts thereof on the same basis as other MAA members.[123] There is therefore virtually complete freedom among MAA membership to adopt in any new aircraft features developed by other companies. The MAA maintains a library and references to inform members of patented technological advances which exist.

Capital requirements.--The enormity of capital required to get into the airframe business is by itself a significant deterrent to new entry into aircraft manufacturing. Chance Vought, the smallest of the largest 12 producers in the military and civil transport markets, had a net worth of $28,700,000 in 1957.[124] Even though Chance Vought owns

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[121]U.S. Congress, Aircraft Production Costs and Profits, p. 1326.

[122]President's Air Policy Commission, op. cit., p. 50.

[123]Howard Mingos (ed.), The Aircraft Year Book for 1945 (New York: Lanciar Publishers, 1945), p. 192.

[124]See Table 21, supra. Except for the helicopter producers, there were only two other smaller prime producers, Stroukoff and Temco, which specialized in production for

no plant, its property value before depreciation and amortization in 1956 was in excess of $11,000,000.[125] The average net worth of the top 12 producers was almost $82,000,000.

Working capital needs in 1958 were considerably greater than prior to 1954 in military production because the Government had reduced progress payments on work completed from 90 percent of costs incurred to 70 percent over this period.[126] Carrying costs are large because of heavy industry investment in inventories due to periodic delays by the Government in taking final action on contracts. The 12 airframe companies had $948,000,000 tied up in inventories at the end of 1957.[127] New entrants cannot look to the Government for much assistance in getting started. Paragraph 13-102.3 of the Armed Services Procurement Regulation states:

> It is the general policy of the armed services that contractors will furnish all facilities required for the performance of Government contracts.[128]

Although in 1956 airframe manufacturers were using government

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these markets in 1958. However, by January, 1958, Stroukoff was producing only one airplane, the YC-134, which had yet to fly. (National Aviation Education Council, Aviation Today, 1958, p. 91.) Temco was producing the TT-1 primary jet trainer for the Navy but was engaged mostly in aircraft modification, overhaul, providing other aircraft services, and some missile work. (Ibid., p. 93 and Moody's Investors Service, Moody's Industrial Manual, 1958, p. 1037.)

[125] Ibid., p. 719.

[126] Lee, Aviation Facts and Figures 1958, pp. 66-67.

[127] Ibid., p. 68.

[128] U.S. Congress, Aircraft Production Costs and Profits, p. 2728.

owned plant and equipment valued at $895,000,000 in contrast to plant and equipment of their own valued at $349,000,000,[129] new facilities in most instances will have to be privately financed in accordance with current policy.[130] Even the Government is somewhat restricted from allowing any prospective entrant from using existing government facilities because of their location. Many of the government plants and facilities are interspersed with those which are privately owned. This would tend to prohibit the leasing of such government facilities on the general premises of another firm.

In order to be competitive expensive research and development are necessary. Returns from such programs are not realized for several years and only if a firm is fortunate to land a sizable production contract.

Empirically, since World War II, the only firms which have entered the military market have been licensee companies[131] which have had large capital backing. Such were Kaiser-Frazer and General Motors during the Korean War.

Conceivably one could get into utility aircraft manufacturing on a small scale without capital being an important deterrent. The relative simplicity of the product signifies that the cost per unit of output is drastically less than military or commercial transport aircraft.

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[129] "Report from Congress: Is U.S. Taxpayer Getting His Money's Worth in Planes?" p. 108.

[130] U.S. Congress, Aircraft Production Costs and Profits, pp. 2728-29.

[131] Companies licensed to produce an aircraft of some other company's design.

Economies of large scale.--The lower costs per unit of production coincident with large scale production in some respects is closely related to capital requirements. If a new entrant cannot provide the capital necessary for plant, facilities, and working capital purposes to produce on a large scale at lower prices, he will experience difficulty disposing of his products at a profit.[132] Capital requirements are extensive to achieve economies of large scale.

It has already been noted that after having received an initial production order, producers in the military market experience declining production costs. Declining production costs and product prices obviate consideration of government sponsored competition between firms for future contracts of the same model aircraft under normal circumstances. In this case economies of scale even prevent other existing airframe manufacturers from competing directly, to say nothing of prospective new entrants.[133]

Technological barriers.--Because of the extreme complexity of the products produced and the extent of concentration among producers, the airframe business is one of the most complex enterprises. Firms must be capable of utilizing the most advanced of scientific knowledge if they

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[132] Joe S. Bain, Barriers to New Competition (Cambridge: Harvard University Press, 1956), p. 55.

[133] Because of the lack of data on reduced unit costs resulting from large scale output in utility aircraft production, no statement can be made concerning this as a barrier to competition in that market.

hope to compete. The products produced are extremely complex. For example, in the control system alone of one guided missile there are approximately 1,500,000 parts.[134] An Air Force bomber has 155,000 parts.[135] A new military jet aircraft requires 10,000 engineering drawings and 25,000 new tools.[136] Each major producer must coordinate orders from thousands of suppliers. Since the advent of weapons system management the job of a prime contractor in coordinating the production has become even more complex. In effect, to be a competent military airframe producer requires unsurpassed technological know-how. Any new producer would encounter the difficulty of having to bid competent personnel away from existing producers.

Such barriers exist in the commercial transport market but perhaps to a lesser extent. However, the top producers in the military market have the advantage of experience in extensive airframe production over any outsider desiring to enter the commercial transport market. This explains why successful military producers are the only commercial transport producers. Boeing, for example, has just re-entered the commercial transport market largely because of experience it gained in the construction of the KC-135 tanker.

The relative simplicity of construction of utility

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[134]Aircraft Industries Association, Plane Views, p. 47.

[135]Ibid., p. 73. [136]Ibid., p. 75.

aircraft reduces the technological barrier to entry in this market sector. Reasons primarily other than technological ones account for there being only nine utility aircraft producers in 1958.[137]

Experience of existing producers.--That which is most prohibitive of new entry in the military and commercial transport market is the experience of producers already in the industry. Their experience stands as the number one deterrent because the Government invites only those to enter design competitions whom it considers qualified to produce the proposed products. The Government determines the qualifications of producers largely on the basis of their past performance in aircraft production.[138] Entry into military airframe manufacturing then is only upon the Government's invitation. Experience is a practical necessity for an invitation. Under these circumstances freedom of entry is completely ruled out. During World War II and the Korean War non-aircraft producers entered the industry with Government encouragement as the economy was being mobilized for the war effort. Since the end of the Korean War, the old experienced airframe producers are again the only prime producers.

As the weapons technology changes other industries

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[137]See Lee, Aviation Facts and Figures 1958, p. 81.

[138]U.S. Congress, Aircraft Production Costs and Profits, pp. 1762 and 1768; and "Air Superiority Formula: Cooperation," p. 7.

may qualify by experience for entry by Government invitation. This has happened noticeably since 1952 with the growing emphasis on missiles. Because of the importance of electronics to the successful operation of missiles, 16 of 40 missiles projects in 1958 had non-airframe producers as prime producers, most of which were electronics firms.[139]

Entry in the commercial transport market is facilitated by production experience by extensive production of military aircraft. Every commercial transport producer in 1958 was primarily a producer of military aircraft. There were no producers of commercial transport aircraft which did not rely primarily on the military market for the sale of their output. The growing complexity of commercial transports in the jet age makes experience in aircraft manufacture even more restricting to entry in the industry by non-aircraft producers.

Experience in the production of military aircraft has facilitated entry of these producers in the commercial transport market. Every military aircraft producer, therefore, is a potential entrant although some producers have an advantage of more military experience than others in the production of heavy aircraft. This fear of entry on the part of other military producers, not to exclude foreign producers of commercial transports, perhaps is a reason why prices on commercial aircraft have not been higher.

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[139]Lee, Aviation Facts and Figures 1958, pp. 41-42.

Inexperience is not a strong deterrent in utility airplane production for the civil market in the same sense that purchases are based directly on a company's successful past performance. In most respects entry in utility plane production is considered easy. Although there are only four successful producers of substantial size, five other producers managed to survive in 1957 with only 3.4 percent of the market.[140]

It would appear then that entry into the military and commercial transport market is extremely difficult. By contrast, entry in the utility aircraft market is relatively easy.

Profits and Growth

One of the most important tests of the competitiveness in an industry is the rate of profit. The Vinson-Trammel Act of 1934 at one time allowed for maximum profits not to exceed 12 percent of sales for firms selling aircraft products to the Government.[141] In practice, in airframe manufacturing profits as a percent of sales have been considerably less. As was disclosed by the Fulbright Committee in 1955, not one aircraft stock appeared in the group of

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[140] Ibid., pp. 77 and 81.

[141] United States Code, Title 34 (1952 ed.), p. 5108. The profit limitation provisions of this act were suspended, however, by the Renegotiation Act of 1948. (Ibid., p. 5109.)

the largest holdings among investment trusts.[142] In comparison with other industrials, profits in aircraft manufacturing do not bear a corresponding relation to sales. In 1954, although Boeing ranked number 20 in terms of sales among the top 500 United States corporations, it ranked only forty-first in terms of net profits.[143] Douglas ranked twenty-sixth in sales but only forty-fifth in net profits.[144] Lockheed ranked forty-second in sales but only eightieth in net profit.[145] This pattern represented the general relation of profits to sales for other airframe manufacturers. Even in World War II, the profit rate in relation to sales of the aircraft industry was the lowest of the war industries.[146] Net profits on sales after taxes amounted to 1.2 percent of sales.[147] It was noted previously that the services allow target profits on contracts between 7 and 10 percent of production costs before taxes. Profits after taxes as a percent of sales are considerably less. Table 27 gives a comparison of the airframe industry with other industries showing profits as a percent of sales after taxes. It can be noted that airframe profits ranged between 2.4 percent

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[142] U.S. Congress, Aircraft Production Costs and Profits, p. 2575.

[143] "The Fortune Directory of the 500 Largest U.S. Industrial Corporations," Fortune Supplement, July, 1955.

[144] Ibid. [145] Ibid.

[146] David C. Cook (ed.), The Aircraft Annual 1946 (New York: Robert M. McBride, & Co., 1946), p. 278.

[147] Ibid.

TABLE 27

NET PROFIT AFTER TAXES AS PERCENT OF SALES, SIX SELECTED INDUSTRIES, 1952-1957

Industry	1952	1953	1954	1955	1956	1957
Nonferrous Metals	7.7	6.9	7.3	9.5	10.5	7.9
Petroleum Products	10.5	10.6	10.7	10.6	10.4	9.7
Autos and Trucks	5.5	4.4	6.4	7.4	5.7	5.7
Railway Equipment	3.8	3.3	4.1	4.7	4.4	4.4
Iron and Steel	5.0	5.7	6.0	7.8	7.2	7.4
12 Major Airframe Companies	2.4[a]	2.4	3.8[a]	3.9[a]	3.4[a]	3.0[a]
Total Manufacturing	5.4	5.3	5.9	6.7	6.0	5.9

Source: Aviation Facts and Figures 1958.

[a]Subject to renegotiation.

and 3.9 percent for the period. No other leading industry averaged as low a profit rate. The average for all manufacturing ranged between 5.3 percent and 6.7 percent. For the period 1946-1954 Boeing's profits after taxes as a percent of sales averaged 3.0 percent.[148] Lockheed's profits after taxes as a percent of sales since 1952 has ranged between 1.7 percent and 3.1 percent.[149] Douglas's profits after taxes as a percent of sales has ranged between 2.13 percent and 3.95 percent[150] for the same period. But even the low rate of airframe profits for recent years is not final. Under provisions of the Renegotiation Act of 1951, these profits are subject to redetermination by the Government.[151] The Government has the legal prerogative of reclaiming any or all of these profits from companies which it judges to be gaining excessive profits in its contracts with the Government.[152] The Government exercises supermonopsonistic power by its ability to re-set prices, in effect, on business already transacted.

Profits after taxes as a percent of net worth gives

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[148]U.S. Congress, Aircraft Production Costs and Profits, p. 1792.

[149]Lockheed Aircraft Corporation, 26th Annual Report, p. 20.

[150]Douglas Aircraft Company, 1957 Annual Report, pp. 34-35.

[151]United States Code, Title 50 (1950 ed.), pp. 7617-27.

[152]Renegotiation will be discussed in more detail in the following chapter.

an altogether different picture. In 1956, for example, the aircraft and parts industry had profits after taxes equal to 21.6 percent of net worth.[153] This contrasts to 15.7 percent for autos and trucks, 19.6 percent for drugs, 15.6 percent for chemicals, 11.9 percent for electrical equipment, and 13.9 percent for total manufacturing.[154] Airframe firms have a large volume of sales in relation to their net worth because roughly two-thirds of the value of production facilities are owned by the Government. For this reason, the ratio of profits after taxes to net worth is extraordinarily high.

There is little evidence to support the view that profits on commercial sales are larger than on military sales. Lockheed estimated about 10 percent[155] and Douglas estimated about 12 percent profits as a percent of sales on commercial contracts.[156] Profits as a percent of invested capital, however, were not larger in general for firms engaged in both commercial and military production in contrast to those engaged in only military production according to the Fortune Directory of July, 1958.

In the utility aircraft market also the profit rate

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[153]Theodore R. Gates (ed.), The Economic Almanac 1958 (New York: Thomas Y. Crowell Co., 1958), pp. 234-35.

[154]Ibid.

[155]U.S. Congress, Aircraft Production Costs and Profits, p. 2535.

[156]Ibid., p. 2222.

was higher than that realized from military sales. Profit as a percent of sales after taxes was 3.3 percent for Beech and 5.1 percent for Cessna in 1957. This rate is derived from total sales, including civil and military. Fifty-six percent of Beech's sales in 1957 were low profit military sales while 43 percent of Cessna's sales were military sales. The greater portion of low profit military sales by Beech than by Cessna accounts for its lower over-all average rate of profits. Piper's rate of profit in 1957 was 10.2 percent of sales after taxes.[157] The higher rate than that of Beech and Cessna is attributed in part to Piper's larger percentage of civil sales. In 1956 only about 7 percent of Piper's sales were military.[158]

The difficulty of entry and the growing demand for the products of the industry has allowed for the growth of sales of the firms in the industry. Firms have grown in terms of net worth also as the increased profits have been reinvested in the industry.[159] Profits play a very important role in providing the necessary capital with which to carry on necessary research and development and facilities expansion. This is especially true when investors are apathetic

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[157]Data for computing rates of profit and sources of sales were obtained from Moody's Investors Service, Moody's Industrial Manual, 1956, pp. 186, 235, and 349.

[158]Data were secured from an answer to a questionnaire submitted by the author to Piper Aircraft Corporation.

[159]"Aircraft Lobby," p. 117.

to new equity financing in the aircraft industry and when Government policy aims at the maximum of private financing in the industry. Increased profits would provide needed capital for necessary research and development and facilities expansion and widen possibilities for new equity financing. In the military airframe industry, it has been claimed that low profits have inhibited the industry's growth.[160] Perhaps most would agree that if profits were greater, more would be invested in the industry. To assert, however, that "low profits" have inhibited the industry's growth is another matter. It does not seem correct to call the airframe industry a "low profits" industry. Profits are considered to be the return over costs incurred by a business. Thus return as a percent of sales for the airframe industry makes the industry appear to have a low rate of return in relation to other industries. But this is deceiving. Profits are more meaningfully related to the rate of return on investment. Income payments to the various productive factors in airframe manufacturing--such as salaries to managerial personnel, wages to employees, interest on borrowed funds, rent on equipment and facilities not owned, etc., have been sufficient to acquire their factor services in the process of production. Return on investment and return necessary to call forth such investment in airframe production is

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[160]For example, see R. M. Loebelson, "How Low Profits Stifle Aircraft Industry," American Aviation, March 3, 1952, pp. 17-18.

contained in profits--this is what remains for the investment after the other productive factors have been paid. Profits as a return on sales is not meaningful because it bears no direct relation to the compensation of capital for productive services.

Profits as a percent of net worth shows that the return on investment in the airframe industry is high. For 12 major airframe producers engaged in military production, profits as a percent of net worth were approximately 17 percent in 1957.[161] As a consequence of the high return on investment and the high reinvestment rate in the industry, net worth almost doubled between 1952 and 1957 in military airframe manufacturing.[162] Net worth more than doubled for utility aircraft producers for the same period.[163] Profits as a percent of net worth were notably higher than in military production. For 1957 Beech's profits as a percent of net worth were 19 percent; Cessna's were 21 percent; and Piper's were 36 percent.

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[161] Lee, Aviation Facts and Figures, 1958, pp. 70-71. Unfortunately, civil transport producers do not publish, nor will they divulge data separating investment devoted to commercial transport production as distinct from that which is devoted to military production. For this reason, nothing can be said here about the relation of profits to investment in commercial transport production.

[162] Net worth for 12 major airframe companies increased from $454,815,000 to $988,254,000 over this five year period. (Ibid.)

[163] The combined net worth of Beech, Cessna, and Piper increased from $20,828,147 to $43,668,212. (Moody's Investors Service, Moody's Industrial Manual, 1958, pp. 186, 235, 349.)

In view of such information it cannot be properly asserted that profits in airframe manufacturing have been low. Indeed, the opposite has been the case. Contrary to being retarded by low profits, if anything the industry's growth which has taken place has been stimulated by the high profit return on investment.

The leaders of the aircraft manufacturing industry strongly criticize the Government's use of net worth as a criterion for evaluating the reasonableness of profits on government contracts. Statements made below during the Hebert Hearings in 1956 by Mr. Clyde Skeen of Boeing Airplane Company summarize the main objections of the industry to this criterion:

1. Return on net worth in the young and growing aircraft industry is compared with the return on net worth of mature industries which made high rates of return in their early development.
2. Return on net worth does not recognize that the aircraft industry has a low net worth in relation to production requirements. This results historically from lack of reasonable profit margins and the peak and valley nature of the business. The combination of these two factors reduces the industry's ability to attract private capital.
3. Return on net worth for a particular year does

not give recognition to earnings recorded during the year as a result of a design, development, and manufacturing cycle that extends over a number of years.

4. Return on net worth does not give recognition to the need for providing adequate funds for new advanced facilities, and research and development.
5. Return on net worth does not reflect the industry's greatest asset--know how.[164]

All of these statements are subject to criticism on economic grounds. In answer to the first statement, why should the Government pay more than that which is necessary to compensate productive resources sufficiently to secure their services in aircraft production? If the Government were to pay more than this in effect it would be subsidizing the industry, and clearly it must be doing this with some other objective in mind than the immediate one of securing the products it needs.

As regards the second statement, it is true that the aircraft industry does have a low net worth in relation to production requirements in comparison with other manufacturing industries. But there is nothing inherently wrong with this. This relation does not result from a low rate of

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[164]U.S. Congress, Aircraft Production Costs and Profits, p. 1794.

profits but from the fact that the Government owns two-thirds of the facilities value used in current production. Further, it is not the low profit rate which reduces the ability of the industry to attract capital but rather the uncertainty because of the peak and valley nature of the industry. As Professor Frank Knight would have it, the rate of profits is high in view of the uncertainty.

In response to the third statement, during each year of the cycle the costs incurred are deductible as production costs of that year reflecting a lower rate of return on net worth on the current production before the new product comes to market. This much is to the industry's benefit in not reflecting a high return on net worth prior to sales of new products. Only if such development costs incurred in producing a new product could be spread in some manner over the entire period of selling that particular product could there be the correspondence between earnings and the manufacturing cycle which the industry would propose.

With reference to the fourth statement, even profits as a percent of sales comparable to other industries, which is the measure on which the industry would like to be judged, does not give any more "recognition" to the need for providing funds for new facilities and research. What the statement really means is that return on net worth does not provide high enough earnings to carry on all the internal financing the industry would like to be doing. The Government does not necessarily have the obligation to provide funds

for new investment out of high profits the value of which will accrue to private enterprise.

Perhaps the most frequently voiced criticism of the industry is that the return on net worth does not reflect the industry's greatest asset--know how. This is not a function of profits in any sense. This technical ability which is referred to is rewarded by other means. The inference is that the productive factors are not sufficiently compensated. This is clearly not the case. Even the Aircraft Industries Association has stated: ". . . aircraft industry employee wages are among the highest weekly wages for all manufacturing employees."[165] Average weekly earnings in the airframe industry in February, 1958, were $98.17.[166] At this same time average weekly earnings in all durable goods industries were $86.46.[167] The airframe industry was exceeded in average weekly earnings by only one of eleven general categories in durable goods industries. It was previously noted that in 1957 military airframe producers received a return on investment of 17 percent of net worth. Returns to both capital and labor therefore have been high. If opportunity costs for their productive services were higher elsewhere, it is doubtful that these productive factors would remain

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[165] Lee, Aviation Facts and Figures, 1958, p. 54.

[166] Ibid., p. 59.

[167] Board of Governors, Federal Reserve Bulletin, 44 (April, 1958), 485.

in aircraft manufacturing.

Synopsis of Competitive Practices

In the military market the power of the monopsonist over sellers is demonstrated in many respects. The monopsonist specifies the product it wants produced. It selects only those which it wants to produce the products and promotes intense competition among them to achieve excellence of design, low cost production, and early delivery. After selection of the product and the producer, it sets the price which will be paid for the product and the quantity to be manufactured. It even has the power of lowering product prices through renegotiation after production and delivery. Entry is only upon invitation of the monopsonist. The oligopolistic sellers are forced into active competition with each other in terms of product differentiation, price, and delivery dates in order to maximize individual firms' profits. Power over rivals can be exercised through design superiority and productive efficiency which results in intensive research and development programs and the hiring of scientific personnel. This results in further competition in the factor market and high factor costs. In the military airframe industry the power of the monopsonist over sellers has significantly offset the power of the oligopolists over the buyer. The result has been extreme progressiveness in product development, low product prices, and production efficiency. Because the monopsonist is the Government in this case, this has been achieved in the public interest.

In the commercial transport market, the oligopolistic producers compete actively in product design and delivery dates. Price competition is less obvious because of the extent of product differentiation in terms of specifications and performance characteristics. The power of oligopolistic sellers over buyers is demonstrated by their ability to administer fixed base prices, demand favorable contract terms, and get well above average profits. Prices perhaps have not been higher than they have been because of fear of new entry by military producers and foreign competition. Oligopsonistic buyers exercise their power by making sellers responsive to their wishes in product design and differentiation. The results have been favorable in progressiveness of product development.

This is an interesting contrast to the military market where prices and profits have been much lower than the average for industry in general. This can be attributed to the monopsonistic power of the Government offsetting the oligopolistic power of the producers. In the commercial transport market the oligopolistic producers have demonstrated more bargaining power in relation to buyers but there has been no evidence presented to suggest that return on commercial investment is higher. The success of the oligopolists in this instance is perhaps because they are fewer in number than the oligopsonists. In the military market with the monopsonistic-oligopolistic structure, one could perhaps make some reasonably accurate general predictions concerning

the outcome of the relation of prices and costs, nature of product produced, and so on. But in the bilateral oligopoly case, as Bain notes: ". . . results are uncertain over a significant range and an observation of actual behavior is the only reliable guide."[168] In the commercial transport industry, it would appear that the oligopolistic sellers are in the more favorable bargaining position.

With respect to progressiveness in product development, it appears that entry or the threat of entry has provided a strong stimulus. Domestic producers were not too perturbed by development of turbo-prop jet transports by the British. But when Boeing announced that it was going to re-enter the commercial market with a pure jet transport, both Douglas and Convair instituted programs for new product development in attempts to retain their market shares.

In utility aircraft manufacturing for the civil market, competition among the several producers is close in a few instances in the sense that there exists some similarity of products and prices in quality categories. Of the 15 aircraft produced accounting for 96 percent of output value in 1957, such competition was "close" in three instances involving seven airplanes. Sales of aircraft closely competitive amounted to about 55 percent of total sales in 1957.[169] In most instances competitors' products

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[168] Joe S. Bain, Pricing, Distribution, and Employment (New York: Henry Holt and Co., 1948), p. 236.

[169] Derived from data obtained from Table 26, supra; and Lee, Aviation Facts and Figures 1958, p. 81.

are significantly differentiated. Firms engage most actively in new demand creation by denoting the economy of business aircraft ownership relative to travel by common carrier. The oligopolistic producers are responsive to the needs of the large number of sellers as evidenced by the variety of aircraft produced. Oligopolistic power over buyers has resulted in very high rates of profit on investment. Prices perhaps have not been even higher because of ease of entry and the existence of a number of smaller producers.

CHAPTER V

PUBLIC POLICY AND THE AIRCRAFT INDUSTRY

The aircraft industry is for the most part a defense industry. In 1956 it was noted that Government purchases accounted for no less than 85 percent of the output value of the industry.[1] By its policies and legislation the Government places numerous controls on both the buyers of the industry's products and the industry itself. The role which the Government plays in its dealings with the industry is therefore very important in conditioning the behavior of the industry. The intent of this chapter is to point out the major policies of and controls exercised by the Government in its relations with the industry. In doing so, first the policy which the Government has followed with respect to civil aviation will be discussed. After this, the role of Government with respect to military airframe manufacturing will be considered.

Government Development and Control of Civil Aviation

Prior to 1925 there was no Government program in effect to foster civil aviation in particular. As a

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[1]See Table 14, supra.

consequence of the controversy over the importance of developing aviation, President Coolidge appointed Dwight Morrow to investigate air power needs. As a result of the findings of the Morrow Board, steps were taken to foster the development of civil aviation. The first of these steps was the passage of the Kelley Bill or Air Mail Act of 1925.[2] The purpose of the act was "to encourage commercial aviation and to authorize the Postmaster General to contract for air mail service."[3] Since 1918, the Army followed by the Post Office had been flying the air mail; now air mail service was to be provided by private air transport operators. The expectation was that the enlargement of air mail services in the hands of private operators would provide an increased demand for aircraft and the growth of that industry.[4]

In 1926 a major step was taken in the development of civil aviation with the passage of the Air Commerce Act of that year. This act was the real forerunner of the Civil Aeronautics Act of 1938. Basically, the act gave the Secretary of Commerce the responsibility of fostering air commerce through the establishment of airports, civil airways, and

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[2]U.S. Statutes at Large, Vol. 43, Part 1 (1923-1925), pp. 805-806.

[3]Ibid., p. 805.

[4]The 1925 legislation was amended in 1926, 1928, and 1930 providing for more generous compensation. The 1930 McNary-Watres Act changed the method of payment from the amount of pounds carried to the amount of space provided for air mail. U.S. Statutes at Large, Vol. 46, Part 1 (1929-1931), pp. 259-60.

navigational aids. It gave him authorization to provide for registration and certification of aircraft and flying personnel and to insure the safe operation of aircraft.[5] This legislation came seven years after the American Aviation Commission stressed the dire need for the Government to assist the development of civil aviation. The committee reported:

> For economic reasons no nation can hope in time of peace to maintain air forces adequate to its defensive need except through the creation of a great reserve in personnel, materiel, and producing industry. Through the encouragement of civil aeronautics, commercial aviation and transportation development must be made to carry the financial load.
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> . . . No sudden creation of aerial equipment to meet a national emergency already at hand is possible. It has been proven within the experience of every nation engaged in the war that two years or more of high pressure effort have been needed to achieve the quantity production of aircraft, aircraft engines, and accessory equipment. The training of personnel including engineering, production, maintenance and operating forces--covering some fifty distinct trades and some seventy-five industries--has proved itself a stupendous task when undertaken upon the basis of the war emergency alone.
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> Past experience and every economic consideration point to the vital need for the formulation by the United States, of a definite, comprehensive and continuing policy for the development of every phase of the aircraft art. Our Government is now faced with the task of pursuing and actively encouraging a new transportation industry, whose healthy growth is vital to future progress and defense of the nation.[6]

Thus the American Aviation Commission had proposed government

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[5]U.S. Statutes at Large, Vol. 44, Part 2 (1925-1927), pp. 368-376.

[6]Mingos, The Birth of an Industry, pp. 52-53.

assistance in the development of civil aviation, principally for national security reasons.

The next significant piece of legislation dealing with civil air transport was passed in 1934 and has been frequently referred to as the Air Mail Act of 1934.[7] The purpose of the act was "to revise air mail laws, and to establish a commission to make a report to the Congress recommending an aviation policy."[8] The act gave the Post Office broader control over airline service and gave the Interstate Commerce Commission the power to fix air mail rates. Section 7 (a) of this act had special significance for the aircraft manufacturing industry.[9] It provided that after December 31, 1934, it would be unlawful for any party holding an air mail contract to have any other interests in the aviation industry other than those in direct support of its transport operation. This meant that the manufacturing and transport operations of the big aviation firms would have to be split up if the firms were to receive the benefit of governmental subsidization in air transport operation.[10] The trustified organizations responded in accordance with the legislation rather than experience the loss of the government air mail business upon which they were heavily

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[7] U.S. Statutes at Large, Vol. 48, Part 1 (1933-1934), pp. 933-39.

[8] Ibid., p. 933. [9] Ibid., p. 936.

[10] The combinations split up were discussed in Chapter One, supra.

dependent in their transport operations. Section 7 (a) also restricted the Postmaster General from granting contracts to any organization paying any official an amount exceeding $17,500 annually. The provisions of Section 7 (a) were largely an outgrowth of the Crane Committee Report which expressed the view that business combinations had prevented the free growth of aviation and had resulted in waste of public funds through higher air mail rates and the payment of huge salaries to company officials.[11] Section 15 of the act was designed to ration out the government subsidies on a more equitable basis.[12] Air mail contractors could not hold more than one primary route and two others of lesser importance.[13] As far as the principal airframe manufacturing companies were concerned, the Air Mail Act of 1934 had special significance as anti-trust legislation.

Since the 1930's the airlines have made progress towards self-sufficiency. In 1938 Public Service Revenues, i.e., subsidies in the form of air mail pay, were 27.9 percent of total airline revenue. By 1957 Public Service Revenues were only 1.9 percent of the airline dollar.[14]

Unified control over civil aviation came with the

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[11] U.S. Congress, House Report 2087, p. 20.

[12] U.S. Statutes at Large, Vol. 48, Part 1 (1933-1934), p. 938.

[13] For discussion of how a few companies were getting the bulk of air mail payments prior to this time, see Chapter One, supra.

[14] Lee, Aviation Facts and Figures 1958, p. 107.

passage of the Civil Aeronautics Act of 1938.[15] Controls relating to civil aviation previously vested in other departments of the Government were mostly given over to an independent agency--the Civil Aeronautics Administration. In 1940 there was additional administrative reorganization including the placement of the Civil Aeronautics Administration within the framework of the Department of Commerce.[16] Basically, the Civil Aeronautics Administration had these functions: to promote aviation by establishing and maintaining the airway system, and by planning and administering the airport program; and to enforce safety rules, test aircraft, examine airmen, control air traffic, and investigate accidents. The Civil Aeronautics Board was created by the 1938 enactment. It was originally called the Civil Aeronautics Authority prior to the 1940 reorganization and had the principal responsibility of economic regulation. It controlled entry, established routes, regulated rates, determined air mail payments and the extent of subsidization. It also prescribed safety rules and investigated accidents

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[15] U.S. Statutes at Large, Vol. 52 (1938), pp. 973-1030.

[16] President's Air Policy Commission, op. cit., p. 157. As early as 1919 the National Advisory Committee for Aeronautics had recommended the creation of a bureau of aeronautics, for much the same purposes, in the Department of Commerce. Dorothy Campbell Culver, Civil and Commercial Aviation. A Guide to Federal Legislation and Administrative Agencies (Berkeley: Bureau of Public Administration, University of California, 1940), p. 1.

both of which were also functions of the CAA. The CAB had the authority to issue cease and desist orders to operators. Rate control has not been an important task of the CAB because airline competition has kept rates low.[17]

It was the CAA which was responsible for the conduct of the Civilian Pilot Training Act of 1939.[18] Ostensibly motivated by military considerations, the purpose of the act was to get a reserve of pilots.[19] Training was free except that students could be required to pay various fees not exceeding $40, and were required to have insurance. For fiscal years 1939 and 1940, the CAA was authorized $5,675,000 for this program and $7,000,000 for each succeeding year until the expiration of the act July 1, 1944.

Not only does the CAA control the conduct of civil aviation by its regulations and policies but it is also the agency through which considerable government spending is distributed for such purposes as grants-in-aid for airports, establishment of navigational facilities and the operation of airways systems and facilities. In 1953 the appropriations for the CAA were in excess of $149,000,000.[20] By 1957 the

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[17]Clair Wilcox, Public Policies Toward Business (Chicago: Richard D. Irwin, 1955), p. 640.

[18]U.S. Statutes at Large, Vol. 53, Part 2 (1939), pp. 855-56.

[19]Bollinger, op. cit., p. 53.

[20]Civil Aeronautics Administration, CAA Statistical Handbook of Civil Aviation, 1957, p. 2.

appropriations for the CAA were in excess of $245,000,000.[21]

The Government has done very little, other than that which has been mentioned, for the development of the light civil aircraft industry. Commercial transport development also has been relatively free from direct government assistance. In 1950, however, Public Law 867, the Prototype Testing Act, was passed by Congress. Its intent was to stimulate the development of advanced transports, particularly in the turbine category, by the Government's underwriting of the costs of operational testing.[22] By the expiration of the act September 30, 1955, it had not been implemented. The Government stands ready to give direct assistance. According to a statement by the Air Coordinating Committee in 1954: "Industry development [civil aircraft manufacturing] will be assisted if necessary by government contracts."[23]

By the sponsoring of research and development and purchases of military aircraft, the Government gives important assistance to the producers of civil aircraft. Much of the information and experience gained in military aircraft research and production is directly applicable to civil aircraft production. It can be said, however, that no real direct government support is given to the civil aircraft

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[21] Ibid.

[22] Air Coordinating Committee, Civil Air Policy (Washington: Government Printing Office, 1954), pp. 62-63.

[23] Ibid., p. 61.

industry. Support is indirect in nature, largely through the CAA, benefits from military aircraft development and manufacturing, government use of facilities for passenger and cargo hauling, and, to a lesser extent, from air mail subsidies.

In 1956 Edward P. Curtiss was given a presidential appointment to study the growth and needs of civil aviation until 1975 to determine the demands which are going to be made on the Government for planning and facilities. The committee reported that by 1975 there would be a 400 per cent increase in general aviation and that air traffic would be twice as great as in 1957.[24] The increase in aircraft would be largely accounted for by business aircraft, the commercial air carrier fleet would increase some, and military aircraft would decrease as missiles replaced them.[25] But despite the small increase in commercial air carriers, airline movements were expected to increase 50 percent and passenger travel even more with the increased air speeds and plane capacities.[26] The Curtiss report recommended that various programs be undertaken to accommodate the increased air traffic and that there be created the Federal Aviation

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[24] Modernization of the National System of Aviation Facilities (Washington: Government Printing Office, 1957), p. 1.

[25] National Requirements for Aviation Facilities: 1956-1975, Vol. I (Washington: Government Printing Office, 1957), p. 1.

[26] Modernization of the National System of Aviation Facilities, loc. cit.

Agency to coordinate and encompass practically all aviation activities with which different agencies of the Government were concerned, including those of the CAA.

Because of several air collisions in early 1958 providing an impetus for central control of aviation, the bill authorizing the creation of the Federal Aviation Agency was passed by Congress August 14, 1958. The new agency will have five basic functions: (1) the development and operation of a common system of air traffic control and navigation for both military and civil aircraft; (2) the regulation of air commerce with the ends of promoting safety and the fulfilling of national defense needs; (3) the promotion and development of civil aeronautics; (4) the control of airspace and the regulation of both military and civil flights; and (5) the consolidation of research and development projects and the operation of navigational facilities.[27] The new FAA absorbs the CAA and the Airways Modernization Board. The CAB, however, still retains its function of economic regulation of the airlines but has lost its authority for safety regulation.[28]

The significance of these contributions by the Government is that perhaps a large number of them would have to be undertaken by private air transport companies and private

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[27]Robert H. Cook, "Congress Approves Federal Aviation Act," Aviation Week, 70 (August 18, 1958), 38.

[28]Ibid., p. 39.

operators were the Government not to do so. Air transport would perhaps be a less profitable enterprise and consequently less civil aircraft would be purchased from manufacturers. Herein lies the importance of such Government actions for the aircraft industry.

Government Policy and the Military Aircraft Industry

On March 3, 1915, the National Advisory Committee for Aeronautics was established by Congress. Since its organization, its functions have been to supervise and direct scientific study of problems of flight. In practice the committee coordinates the research needs of private, commercial, and military aviation. It conducts applied research to increase the performance, safety, and economy of aircraft operation.[29] Although the committee operates directly in the interests of civil as well as military aviation, the latter has made wider use of its findings. Considerable funds are expended for facilities and the conduct of research and development by the NACA. It is estimated that in 1959 over $100,000,000 will be spent by this activity.[30] Since 1953 expenditures of the NACA have remained above $71,000,000 annually.[31] The NACA is the oldest

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[29] President's Air Policy Commission, op. cit., pp. 153-54.

[30] Lee, Aviation Facts and Figures 1958, p. 48.

[31] Ibid.

and most continuous form of federal assistance to the industry outside of aircraft purchases.

World War I revealed that the Government had virtually no policies to follow in dealing with aircraft manufacturers. Both the investigations of the Thomas Committee and Charles Evans Hughes in 1918 revealed the extremely high profits reaped by those who engaged in aircraft manufacturing during the war, and the poor record they had in producing satisfactory products.[32] Mismanagement was more true of the Army than the Navy air program. The Navy established the Naval Aircraft Factory during the war and had a better means thereby to judge what were fair prices charged by other aircraft builders. It was during this period that the Government first discovered that it could get expanded production by placing orders and subcontracts with non-aircraft producers, especially the automotive industry.

For six years after the war there existed no policy designed to keep the industry alive. Both government and civil orders diminished until its existence was seriously threatened. In 1924 the NACA observed in its annual report:

> The present American aircraft industry is but a shadow of that which existed at the time of the armistice. Civil aviation has not developed as it was hoped it would, and this makes the situation more difficult. The aircraft manufacturers have had to rely for orders upon government agencies, and the limited amount of government purchases has forced a number of manufacturers to go out of the aircraft

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[32] Freudenthal, op. cit., pp. 49-50.

> business. It is a matter of grave concern lest the productive capacity of the industry may be so far diminished that there may not remain a satisfactory nucleus. By a satisfactory nucleus is meant a number of aircraft manufacturers distributed over the country, operating on a sound financial basis and capable of rapid expansion to meet the government needs in an emergency.[33]

This warning, General William Mitchell's dramatic appeal for air power, and the stirring report of the Morrow Board, incited the policy makers into action. It has been noted already that civil aviation received the benefit of the Air Mail Act of 1925 and the Air Commerce Act of 1926. Military aviation stood ready to benefit from these acts should an emergency develop and from two other acts passed by Congress, one of which concerned the Navy and the other the Army Air Corps. The first of these acts provided for the procurement of 1,614 aircraft by the Navy at a cost not to exceed $85,078,750 between fiscal years 1927 and 1931.[34] Another important feature of the act was that it authorized the Secretary to build aircraft and parts if contractors' bids were too high.[35] The Army provided for a similar program by what has been called the Air Corps Act of 1926.[36] The act provided that the Secretary of War was authorized to equip the Army Air Corps with up to 1,800 serviceable airplanes. The build-up was to take place

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[33] Mingos, Birth of an Industry, p. 83.

[34] U.S. Statutes at Large, Vol. 44, Part 2 (1925-1927), pp. 764-68.

[35] Ibid., p. 766. [36] Ibid., pp. 784-90.

over the fiscal years 1927 through 1931. Specific procedure to be followed by the services in advertising for competitive bidding on service contracts was provided for, although direct negotiation was also permitted at the discretion of the Secretary of War or the Secretary of the Navy.[37] The legislation stated that the Government could acquire a manufacturer's winning aircraft design without giving him the production contract, and that compensation for a design was not to exceed $75,000. The significance of these acts was that the Government had finally adopted a policy which was designed to stabilize the industry over time, though at a very low level of output.

In execution of the five-year programs the Government placed orders among 10 of an estimated 286 aircraft manufacturing firms, and two companies secured 75 percent of the business.[39] This policy of concentration of orders among a few firms determined which firms would survive. Generally speaking, those firms not fortunate enough to get government contracts did not survive. By the end of the five-year programs many aircraft manufacturers had gone out of business.

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[37] Ibid., p. 787. It was necessary, however, to secure three bids on proposed work when advertising was not publicly used. Negotiated contracts were to be used principally for purchasing designs of advanced equipment.

[38] Ibid., pp. 786-88.

[39] See Chapter One, supra.

Military aircraft procurement again dropped off upon completion of the five-year programs in 1931. It was not until 1935 that the Army and the Navy once again embarked upon five-year programs calculated to give the industry stability.[40] These programs were undertaken upon the recommendation of the Baker Board because purchases of civil aircraft alone were insufficient to avoid contraction of the industry. Additional features of the Vinson-Trammel Act, which authorized the Navy procurement, were that contractors' profits were limited to 10 percent of sales and that no less than 10 percent of the aircraft procurement authorized under the act were to be manufactured in Government plants.[41] Legislation of April 3, 1939, made the profit limitation on aircraft contracts 12 percent of the contract price for both the Army and the Navy.[42] If losses occurred or if profits were less than the 12 percent for any year, the difference would be allowed as credit in determining excess profits in the succeeding four years.[43] By 1938 the new five-year programs were not providing for sufficient production in terms of meeting the growing air power threat of other countries. Several new authorizations

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[40]See Freudenthal, op. cit., pp. 231-32.

[41]U.S. Statutes at Large, Vol. 48, Part 1 (1933-1934), pp. 503-505.

[42]U.S. Statutes at Large, Vol. 53, Part 2 (1939), p. 560.

[43]Ibid.

commencing in 1938 allowed for yearly procurement increases for seven consecutive years.

During World War II the Government adopted a radically different policy concerning the aircraft industry. The Government financed and retained title to much of the plant and production equipment constructed during the war. Private manufacturers leased the facilities from the Government.[44] The small amount of privately financed plant and equipment expansion which occurred was in most cases encouraged by a provision for accelerated amortization over a 60 month period under the provisions of the Second Revenue Act of 1940.[45] If facilities expansion took place with the view of producing for the war effort and if the emergency ended in less than 60 months from the date of construction, then the facilities could be amortized over the shorter period and taxes were to be recomputed on the new basis.[46] The Government under certain conditions offered to pay unamortized costs of facilities.[47] Under its wartime policy, the Government became a heavy owner of the industry's facilities.

To get increased output, the Government placed orders

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[44]It was noted above that emergency facilities expansion in the aircraft industry from 1940 to 1945 cost $3,894,000,000. Of this sum less than 11 percent was privately financed. See Chapter One, supra.

[45]U.S. Statutes at Large, Vol. 54, Part 1 (1939-1941), p. 1,000.

[46]Ibid. [47]Ibid., p. 1,002.

with cross-licensed producers and non-aircraft producers. The Government increased subcontracting to the point where it accounted for around 30 percent of total pounds of aircraft produced during the war compared to 10 percent under license agreements.

Besides the new policy of facilities ownership, the Government suspended the practice of competitive bidding on contracts by an act of July 2, 1940, because negotiated procurement was regarded as most expedient.[48] Competitive bidding had been the desired procurement practice of both the services as was provided for in the same legislative acts which authorized the first five-year programs.[49]

Another departure from previous policy was provided for in legislation which authorized the renegotiation of contracts by the Government. The Vinson-Trammel Act of 1934 had provided for profit limitations of 10 percent of contract prices and the Seventy-sixth Congress passed legislation in 1939 providing that profits in excess of 12 percent of contract price on all aircraft procurement by the Government were refundable. Although the principle of returning profits above a certain percent of costs had therefore been in practice, the principle of returning profits judged excessive on other bases was first enacted in 1942

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[48] U.S. Statutes at Large, Vol. 54, Part 1 (1939-1941), p. 712.

[49] See U.S. Statutes at Large, Vol. 44, pp. 776 and 784.

in a defense appropriation act.[50] Any contract or subcontract for over $100,000 was subject to renegotiation. Several changes as to administration and responsibility of renegotiation were made in the Renegotiation Act of 1944.[51] Prime contracts were subject to renegotiation if they exceeded $100,000 as before, but subcontracts came under the provision of the act if they exceeded $25,000. The decision-making body, the War Contracts Price Adjustment Board, was created by this act.[52] It was the duty of this board to review defense contracts to determine whether profits earned were excessive even after excess profits tax payments. In this manner the Government had made special provisions to avoid any post-war scandal concerning excessive profits earned by defense industries such as had occurred after World War I.

Taxing and renegotiation appear to have had some measure of success in recapturing excessive profits. Although the 12 major airframe companies had a net profit after taxes of $350,300,000 between 1940 and 1945 inclusive, they paid $1,171,300,000 in federal taxes.[53] Before

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[50]U.S. Statutes at Large, Vol. 56, Part 1 (1942), pp. 245-46. This act is popularly referred to as the Renegotiation Act of 1942.

[51]U.S. Statutes at Large, Vol. 58, Part 1 (1944), pp. 21-94.

[52]Ibid., p. 85.

[53]Lee, Aviation Facts and Figures 1958, p. 71.

renegotiation became operative, the 12 major airframe companies had net profits after taxes of sales of 12.9 percent in 1940 and 7.4 percent in 1941.[54] Following the Renegotiation Act of 1942 for the duration of the war the rate was never more than 2.2 percent and was as low as 1.0 percent in 1944.[55] Federal taxes as a percent of total income increased from 26.9 percent in 1940 to a high of 72.6 percent in 1942 and remained around that rate until 1945.[56]

Government Policy in the Cold-War, 1946-1958

With the war over it was necessary to review the peacetime needs of a defense program. The Mead Committee, a special committee of the Senate for investigating national defense, in 1946 stressed the necessity for supporting the aircraft industry:

> The aircraft industry must continue to produce combat airplanes on a scale adequate to maintain constantly a well-trained, properly balanced, experienced staff of workers and technicians who can keep abreast of the most improved and efficient aircraft manufacturing techniques and produce the latest types of combat aircraft.
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> . . . It is also necessary to order in sufficient quantity for all the manufacturers to undertake at least a minimum of the production engineering, planning, and tool design needed to develop mass-production techniques.[57]

The same year a permanent Government agency, the Air Coordinating Committee, was formally established. The

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[54] Ibid., p. 73. [55] Ibid. [56] Ibid.

[57] Cleveland, op. cit., p. 217.

continuing task of this committee was to bring about the fullest development and integration of United States aviation policies and activities.[58] The report of this committee in 1947 was essentially the same as that of the Mead Committee. The report stated:

> Military procurement in peacetime must be at a level adequate to insure the national security based on: (1) the current requirements for aircraft, and (2) the need for maintaining an industry which can produce aircraft of superior design and performance, carry on research and engineering development of new types, and expand to meet mobilization requirements.[59]

On the strength of such reports, the President created the temporary Air Policy Commission to make a thorough study of current and future needs of American aviation and make recommendations to serve as a guide in the formulation of a national air policy.[60] In addition to other recommendations, the Air Policy Commission recommended an Air Force of 70 combat groups,[61] increases in air mail subsidies to airlines,[62] and the creation of the Government Aircraft Development Corporation.[63] The development corporation would help finance all or a portion of the development cost of

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[58]Air Coordinating Committee, First Report of the Air Coordinating Committee (Washington: Government Printing Office, 1946), p. 1. The committee was composed of members of Government agencies which possessed a primary interest in aviation activities.

[59]Air Coordinating Committee, Air Coordinating Committee Report, 1947 (Washington: Government Printing Office, 1947), p. 15.

[60]President's Air Policy Commission, op. cit., pp. v-vi.

[61]Ibid., p. 25. [62]Ibid., p. 101. [63]Ibid., p. 137.

aircraft, principally transport types. The objective behind this proposal was to promote a fleet of transport type aircraft which, though it would be of immediate assistance to the commercial air transport industry, would be available for military use in time of war.

None of the recommendations of these responsible committees had been implemented to the extent proposed prior to the Korean War. No Government Aircraft Development Corporation was created, the movement for air mail subsidy was thwarted, and the 70 groups Air Force was held to 48 groups.[64] Although appropriations for the military air arm had increased in 1948, by 1950 the trend was once again in the other direction.[65] With the Korean War and the growing realization of the necessity for countervailance of the Russian arms build-up since then, the net effect of the policies of the Government with respect to the aircraft industry has been such as to promote its development. They have been undertaken only as the threat of war has become imminent. The measures taken have been immediate ones and have not been the results of long range planning for stability.

That which follows is a discussion of the policies which have pertained to the military airframe industry during the cold war.

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[64]Edward L. Allen, Economics of American Manufacturing (New York: Henry Holt & Co., 1952), pp. 326-27.

[65]See Chapter One, supra.

Procurement.--There has been an apparent lack of long range procurement policy for purchasing products of the aircraft industry. Air Force wings were successively programmed at 66, 55, 48, 42, 95, 143, 120, and 137 wings, all in the period of 1950 through 1955.[66] In the opinion of the Air Policy Commission such lack of stability in planning results in increased costs to the Government.[67] Procurement rather has been on a very short run basis depending to a large extent on the annual budget appropriation which in turn has been dependent on the then current state of international tension.

Given the budgetary limitations, procurement for the armed services is basically governed by the Armed Services Procurement Act of 1947.[68] The act limits profits on cost-plus-fixed-fee contracts to 10 percent of costs. For experimental work the limit is 15 percent.[69] The act stresses the intention of the Government to purchase from small businesses.[70] Airframe manufacturers are in effect forced to subcontract to remain in good standing with the Government.[71] In 1954, of total disbursements of

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[66] W. Barton Leach, "Obstacles to the Development of American Air Power," The Annals of the American Academy of Political and Social Science, 299 (May, 1955), 67-75.

[67] President's Air Policy Commission, op. cit., p. 60.

[68] U.S. Statutes at Large, Vol. 62, Part 1 (1948), pp. 21-26.

[69] Ibid., p. 23.

[70] Ibid., p. 21.

[71] U.S. Congress, Aircraft Production Costs and Profits, pp. 2532-33.

$8,744,270,000 of 35 major aircraft manufacturers, about 54 percent was paid out for services and products of subcontractors and suppliers. Of this amount paid out, approximately 42 percent went to firms employing less than 500 people.[72] Another feature of the act is that it reaffirms the position that Government procurement is to be made only after advertising and will go to the low bidders.[73] There are, however, 17 different exceptions to this general rule of competition for contracts, one of which allows contract negotiation without competitive bidding during national emergencies. In 1956 an investigation revealed that 92 percent of the dollar value of military procurement was done without advertised competitive bidding.[74]

The trend since 1956 is for procurement of the Government to be handled by fewer prime contractors. Under the practice of weapons system management, there are fewer prime contractors responsible for management and procurement functions once handled by the Government.[75] In the past, procurement has been allocated so as to provide for a broad industrial base upon which to expand. This policy has been abandoned because of the belief that a nuclear war will be a short one and would not provide an opportunity to use a

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[72] U.S. Congress, The Aircraft Industry, pp. 234-35.

[73] U.S. Statutes at Large, Vol. 62, Part 1 (1948), pp. 21-22.

[74] "House Group Sounds a Warning on Non-Competitive Military Buying," Business Week, July 6, 1957, p. 83.

[75] "Who Is Running the Aircraft Industry," Aviation Week, 64 (April 16, 1956), 21.

broad industrial base. These two factors point the way for concentration of orders among fewer producers in the future.[76]

Government investment.--The Government invested heavily in production facilities during World War II. The presence of these facilities has been important in accounting for the Government's owning most of the plant and equipment in use in the post-war era. In 1956, twelve major airframe firms used their own property valued at $394,682,478 in contrast with Government owned property worth $895,854,410.[77] Government ownership of aircraft production facilities therefore accounted for approximately 70 percent of the value of these facilities in use in the industry.[78] Even in peacetime the Government has been investing in production equipment. In 1952 it embarked on a program to buy heavy presses costing in total up to $125,000,000.[79] The Air Force tool policy is to have its tools in active use rather than build

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[76]It is expected that subcontracting will also decrease when it becomes more the function of manufacturers to decide between in-plant production and subcontracting. Management control and better utilization of the prime's space, resulting in lower costs, are factors which will work against maintaining as high a level of subcontracting as has existed in the past. See Merrill Lynch et al., op. cit., p. 7, and Day, op. cit., pp. 42-43.

[77]U.S. Congress, Report on Aircraft Production Costs and Profits, p. 3115.

[78]Other facilities acquired by the Government during the war which have since been sold or leased can be recaptured by the Government in the event of war under the provisions of the National Reserve Act of 1948. This act also provided for a reserve of government owned industrial plants not easily converted to peacetime use. (See Goldberg, op. cit., p. 217.)

[79]I. Stone, "USAF Puts Its Money on Big Squeeze; Heavy Press Program," Aviation Week, 57 (July 7, 1952), 40.

up an unused reserve. The reasoning behind its active tool plan is that in the event of war there would be little opportunity for mobilization beyond that which already existed and hence little use could be made of an inactive tool inventory.[80]

The Government has expressed two views favoring its investment in aircraft production facilities. One view is that some of the money which it has invested is recovered through reduced production costs because lower product prices are allowed producers using low-rent or rent free government facilities. A second view, one which is believed to justify their existence in the first place, is that the United States could not have reached the high level of output of planes during World War II without government investment. Private investors would not have been willing to supply the amount of capital for production facilities in the stress of war and with the uncertainty of future business.[81]

In some instances the Government charges rent for use of its facilities and in other instances it does not. The recommendations of the Hebert Committee were that the Government should not charge rent for its facilities in that it raises operating expenses and provides a higher return

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[80] "USAF Defends Active Tool Plan Before Small Business Committee," Aviation Week, 64 (February 13, 1956), 36.

[81] U.S. Congress, Report on Aircraft Production Costs and Profits, pp. 3111-12.

for firms than if operating expenses were lower.[82] The Hebert Committee recommended disposal of Government facilities which were dispersed among those of private owners. Otherwise, it was recommended that the Government retain facilities which might otherwise have to be reacquired at higher prices than those at which they were liquidated.[83] Government ownership of facilities is largely a consequence of the war. In general, it was the view of the Hebert Committee that it would be preferable if the Government did not own the facilities used by the industry, but because it does, it should employ them in the best interests of the public.

Special government controls.--Aircraft firms receive much closer surveillance than do non-defense industries doing business with the Government. The services assign plant representatives for duty with the leading prime manufacturers. Government contracting officers are also in residence at manufacturers' plants. Such personnel seek to insure that producers adhere to government policy. Air Force inspectors examine components and completed aircraft before acceptance to insure quality.[84] Visits by mock-up boards and technical compliance boards have been so numerous in the past that manufacturers have complained that this has

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[82] Ibid., p. 3112. [83] Ibid.

[84] "Air Force Watchdog of Quality," Aviation Week, 57 (August 4, 1952), 213.

hampered productivity.[85] As many as 200 officers and civilians on a single board have been inspecting plant operations.[86]

Controls over the industry have increased to the point where the Aircraft Industries Association, the trade organization of the industry, has protested the usurping of its prerogatives.[87] Contractors object to having to provide detailed accounts of proposed subcontracting, including the listing of parts, names and locations of subcontractors, etc. They object to the power of the contracting officer to veto and alter management decisions in production planning and scheduling, and so on.[88] One company executive remarked concerning Air Force intervention:

> Colonels have run--in the fullest sense of the word--the biggest bomber plant in the country. And young captains have dictated to the oldest engineers in this complex business the exact procedure for a minor part development.[89]

The view of the Air Force is that a number of increased controls have become necessary. Congressional pressures, the emphasis on economy, and the complexity of the modern weapons system have brought on such measures. The intent of the Air Force is not to exercise controls properly belonging to the industry. According to the Assistant

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[85] "Industry Complaints Bring Limits on Visits by Inspection Boards," Aviation Week, 64 (February 27, 1956), 34.

[86] Ibid.

[87] C. Witze, "USAF Control Over Industry Charged," Aviation Week, 64 (April 16, 1956), 26.

[88] Ibid. [89] Ibid., p. 27.

Secretary of the Air Force, Dudley C. Sharp, such practices are to be stopped.[90]

Although Government supervision of the industry's activities in general has been encompassing, it has allowed the industry to violate at least one important legislative act. According to a report of the Federal Trade Commission, practically all the important manufacturers in the aircraft industry had interlocking directorates.[91] A number of instances were in direct violation of Section 8 of the Clayton Act. The Government has such pervasive control over the industry it is doubtful that interlocking directorates in this instance could result in much which was contrary to the public interest as relates to military production, at least.

Dispersal.--Since the end of World War II, the Office of Defense Mobilization has urged the aircraft industry to disperse as much as possible so that each strike of a nuclear bomb would be less crippling to the industry. Prior to 1958, firms which dispersed could write off new facilities investment coincident with dispersal on the war-time basis.[92] The view of the Air Force in this regard is not that the

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[90]C. Witze, "Sharp Says USAF Won't Wield Excessive Control Over Industry," Aviation Week, 64 (April 23, 1956), 41.

[91]Federal Trade Commission, Report of the Federal Trade Commission on Interlocking Directorates (Washington: Government Printing Office, 1951), p. 305.

[92]J. Chamberlain, "Sikorsky Affair; Dispersal of Industry Will Not Be Easy," Barron's, 33 (December 14, 1953), 3, 21.

industry should abandon existing sites in favor of new ones. Rather, it believes that new expansion should locate in areas which are less populated and where the industry is less concentrated.[93]

Federal and Local Tax Policies.--During the period 1946-1958, federal taxes of 12 major airframe companies were greater than net profits every year except 1949 and 1950. In 1957 federal taxes amounted to $180,400,000 and net profits of the 12 major airframe companies were $166,400,000 before renegotiation proceedings.[94] Net federal taxes as a percent of total net income has ranged between 37.5 percent and 82.3 percent for these 12 producers since World War II.[95] Between 1954 and 1957 federal taxes as a percent of net income stayed around 51 percent.[96]

As a defense industry, aircraft manufacturers have been authorized to depreciate their facilities on an accelerated basis. During World War II, only around 10 percent of the aircraft facilities expansion was privately financed. Of this amount about 85 percent was certificated by the Government for accelerated amortization. This was done under the authority of a 1941 amendment to the Second Revenue Act of 1940 which allowed contractors certification

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[93] "Talbot Clarifies Dispersal Policy," Aviation Week, 62 (May 9, 1955), 13-14.

[94] Lee, Aviation Facts and Figures 1958, p. 71.

[95] Ibid., p. 73. [96] Ibid.

to amortize facilities considered necessary to the war effort over a 60 month period or duration of the emergency whichever was less.[97] During the Korean War, Section 124A of the Internal Revenue Code, which provided for accelerated amortization, was included in the Revenue Act of 1950. During World War II these "Certificates of Necessity," as they are called, covered 100 percent of facility costs. Under the later provisions, however, depreciation could not be "ballooned" over a shorter period if the emergency was less than five years, and certificates which were awarded averaged around only 65 percent of facilities cost.[98] More than $1,000,000,000 of privately financed expansion was proposed over a three year period from the start of the Korean War under the stimulus of the accelerated write-offs.[99] Certificates of Necessity have been the means by which the Government has sought to get the industry to undertake facility expansion rather than have the Government do it as it had during World War II.[100] Certificates of Necessity authorize contractors to recover the full amount covered by the certificates by adding one-fifth of the amount to the price of the products during each of the five years of accelerated

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[97] R. Modley, "Tax Hazards of Plant Expansion," Aviation Week, 54 (June 25, 1951), 40.

[98] H. W. Strangman, "Aircraft Industry in a Cold War Economy," Commercial and Financial Chronicle, 175 (May 15, 1952), 2014.

[99] "Tax Benefits Spur Plant Expansion," Aviation Week, 59 (November 2, 1953), 21.

[100] Modley, "Tax Hazards of Plant Expansion," loc. cit.

amortization.[101]

The rapid technological change and the new materials and new designs in the aircraft industry have caused equipment in the industry to become obsolete in less than the average 12 year period over which it was to be depreciated during much of the post war period.[102] Regulations of March 21, 1958, however, allow for "true depreciation" in negotiated contract pricing. According to the Air Force Procurement Instruction:

> For the purpose of cost computations in negotiated contract pricing, true depreciation, which includes any extraordinary obsolescence reasonably assignable to the emergency period, is allowable. Any accelerated amortization of depreciation which is in excess of true depreciation, regardless of whether such excess is included in tax amortization certificates, is not allowable as an element of cost in negotiated contract pricing.[103]

Until 1957 the Department of Defense had been allowing local taxes of aircraft manufacturers as allowable costs on contracts.[104] Several California counties, for example, have increased their tax-take by applying the 6 percent personal property tax to the industry's inventory. That inventory for which Government progress payments had not been received was considered company's property and was therefore

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[101] Ibid., p. 45. [102] Hurley, loc. cit.

[103] U.S. Air Force, Air Force Procurement Instruction, Part 9, Sect. 3-909, revised March 21, 1958 (Washington: Government Printing Office, 1957), p. 399.69.

[104] R. Sweeny, "Local Taxes on Aircraft Industry Hinge on Beneficial Interest Ruling," Aviation Week, 67 (July 15, 1957), 30.

taxable.[105] The Defense Department no longer allows such taxes as reimbursable as a result of the decision by the Superior Court of Los Angeles County that the tax is illegal. Pending an appeal to the State Supreme Court, however, manufacturers must continue to pay this tax with no reimbursement on government contracts.[106]

Renegotiation.--There have been various measures adopted by the Government for recapturing profits of aircraft manufacturers since the Vinson-Trammel Act of 1934. Legislation of 1939, the Renegotiation Act of 1942, and the Renegotiation Act of 1944 have been discussed above. These acts have been the antecedents of two similar legislative acts of the cold war. The first of these was the Renegotiation Act of 1948.[107] The 1944 act had applied to contracts in excess of $100,000 and subcontracts of more than $25,000. With the lower volume of peacetime purchases, the 1948 act was passed which stated that all contracts and subcontracts in excess of $1,000 were subject to renegotiation. Contracts subject to this act did not come under the profit limitation provisions of previous acts such as the Vinson-Trammell Act.[108] During the Korean War there was need for a revision of

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[105]"Aircraft Firms Fight New California Tax," Aviation Week, 59 (November 30, 1953), 18.

[106]Sweeny, loc. cit.

[107]U.S. Statutes at Large, Vol. 62, Part 1 (1948), pp. 258-61.

[108]U.S. Code, Title 34, 1952 ed., p. 5109.

renegotiation legislation. Subsequently the Renegotiation Act of 1951 was passed on March 23 of that year.[109] Contracts subject to this act were also exempted from the profit limitations of previously applicable legislation.[110] It raised the limits on contracts which would become subject to renegotiation to a minimum of $250,000 received during a fiscal year. Excess profits less than $250,000 could not be reduced.[111] Another feature of the 1951 act was the creation of the Renegotiation Board which took over the functions once exercised by the War Contracts Price Adjustment Board. The Renegotiation Board is responsible for making decisions on whether excess profits have been earned and are to be recaptured by the Government. Since the passage of the Renegotiation Act of 1951, which was to expire December 31, 1953, it has been periodically renewed and was still in effect in 1958.

The several renegotiation acts since 1942 vary with reference to whom they apply and as to their administration but the basic purpose behind their enactment has not changed. This has been stated by Mr. Carl Vinson, Congressman from Georgia:

> The sole objective as well as the net result of a renegotiation proceeding is to make certain that the Government has paid no more to a contractor, directly

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[109] U.S. Code, Title 50, 1952 ed., pp. 7617-28.

[110] Ibid., p. 7617. [111] Ibid., p. 7623.

> or indirectly, than he should in good conscience be entitled to receive in the circumstances--in a word, that from the efforts of the Government to maintain the common defense for the common good, he has not accumulated more than a fair return or overall price for what he has done. The purpose is not to take money away from the contractor, but rather to see that not too much money has been taken from the Government under unusual conditions lacking the controls normally exerted upon prices by the pressures of competition.[112]

The main argument for retaining renegotiation legislation is that defense equipment has become so complex and technological change is so rapid, that the past production experience is not sufficient upon which to base prices including a reasonable profit. In order to avoid the possibilities of exorbitant profits, the Government wants the prerogative of being able to renegotiate the contract after the business has been fully transacted to assure this outcome.

There is no explicit formula followed by the Renegotiation Board in determining how much if any of a company's earnings are to be recaptured. A Renegotiation Board press release of February 14, 1956, stated that renegotiation was determined "by an overall evaluation of all statutory factors."[113] Such factors include a company's risk, efficiency, net worth, inventiveness, complexity of the business, volume of production, and several others.[114] In the final analysis, it is strictly a matter of discretion on the part

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[112] U.S. Congress, Aircraft Production Costs and Profits, pp. 2905-2906.

[113] U.S. Congress, Report of Aircraft Production Costs and Profits, p. 3116.

[114] U.S. Code, Title 50, 1952 ed., p. 7618.

of the board.

Since 1951 airplane manufacturers have perhaps voiced more opposition to renegotiation than to any other government policy. They note that their profits as a percent of sales are low compared to other industries even before renegotiation proceedings. Further, renegotiation is said to destroy incentive. For example, from 1952 to 1954 Boeing, Grumman, Lockheed, and North American made a combined $54,846,892 in incentive earnings.[115] But after Renegotiation Board proceedings, the Government took back from these companies $64,000,000 of what were determined to be excess profits for the period.[116] The industry charges that such actions work contrary to the incentive to bring about savings when the board reclaims a portion of the savings--and sometimes more--that was given in reward for efficiency. In place of renegotiation some members of the industry have proposed that the Government grant contractors a basic profit on work accomplished plus a reward for efficient performance.[117]

The Hebert Committee found that the basis for renegotiation was so vague that producers had no way of knowing how to conduct their business so as to avoid statutory

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[115] Incentive earnings are rewards for having produced below anticipated costs.

[116] "Renegotiation Act Hit," American Aviation, 22 (August 11, 1958), 21-22.

[117] Ibid., p. 21.

renegotiation.[118] Another criticism was that board actions were undertaken several years after contract results were known. Knowing that they were subject to renegotiation, contractors were hesitant to commit capital to investment which might later be demanded as excess profits.[119]

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[118] U.S. Congress, Report of Aircraft Production Costs and Profits, p. 3116.

[119] Ibid., p. 3117.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The invention of the airplane in 1903 and the growth of the aircraft industry which followed were preceded by centuries of experimentation in aircraft development. Results of the numerous experiments in gliders and engines provided some helpful information to Wilbur and Orville Wright. However, most of the scientific data necessary before sustained human flight could become a reality was gathered by the Wrights from their own experiments.

Industrial development in aircraft manufacturing was slow until World War I when aircraft were mass produced as weapons of war. After the war was over there was little demand for aircraft until around 1927 when Charles Lindbergh made his trans-Atlantic flight and others set air speed and endurance records. But the level of output and employment in the industry again declined sharply after 1929 as flying popularity died down and the depression got underway. By 1935 production was stimulated by the increased foreign demand due to international tensions abroad. Finally, the preparation for and the involvement in World War II brought on increased production of aircraft to such an extent that it became the largest industry in the United States in terms of employment and value of production. The increased demand

for utility aircraft and commercial transport aircraft did not offset significantly the drastic reduction in military demand for the products of the industry following the war. With the threat of the "Cold War," annual expenditures for aircraft increased from 1948 through 1953 when the three year Korean War was ended. Since 1954 annual expenditures for the products of the industry have increased as the "Cold War" has continued. Historically, the value of military aircraft production has been much in excess of production for the civil market. Except for the "Lindbergh Boom," the only periods of general prosperity and growth in the industry have followed the threat of war or have been during wars.

Technological change and new product development has been ever present in the 40 year history of the industry. Manned combat aircraft, which have accounted for by far the largest portion of aircraft sales in the past, are presently being superseded by pilotless missiles. Although the aircraft firms are prime contractors on most missile projects, entry by electronics firms into the production of missiles is taking place.

The present market for the products of the industry is divided into two main sectors--the military market and the civil market. The civil market sector is further subdivided into the market for commercial transport aircraft and utility aircraft. With respect to the relative importance of each market sector in 1956, military aircraft sales

accounted for approximately 85 per cent of total aircraft sales. The civil market accounted for the remaining 15 per cent of total aircraft sales of which commercial transport aircraft sales constituted slightly more than 13 per cent and utility aircraft sales slightly less than two per cent.

The buyer's side of the military market is monopsonistic in structure in that the Government is the only purchaser of these products of the industry. In the commercial transport market, the buyers' side of the market is oligopsonistic in that important buyers of the products of the industry are few in number. Seventy-six per cent of aircraft in scheduled operation in the United States in 1956 were operated by 12 of 40 scheduled air transport companies. This is not to overlook the point that exports of commercial transport aircraft represented 34 per cent of the value of output of this type aircraft in the period 1952 to 1956. The buyers' side of the utility aircraft market is "competitive" in structure because buyers number in the thousands. The lack of concentration permits no special bargaining power for the individual buyer in the purchase of aircraft.

There is considerable concentration on the sellers' side of the aircraft market. In 1956 the top five military producers accounted for approximately 75 per cent of airframe sales. For several years prior to 1958 there were only three domestic producers of aircraft in the commercial transport category. Four producers of utility aircraft

accounted for approximately 97 per cent of the output value in 1957. In terms of output value, there exists considerable concentration among a small number of producers for the airframe industry as a whole. In the late 1920's the industry had at least as many as 296 producers of aircraft. The existence of a small number of large producers today has been largely a consequence of the Government's decision to spread its order over a few airframe producers. Survival of producers has been largely dependent on receiving government contracts.

Concentration of orders among few producers has determined the technology of large scale production on an assembly line basis which in turn has resulted in economies of scale. As large scale production techniques have been employed and as aircraft have become increasingly complex, the composition of the labor force in the industry has been changing to larger proportions of unskilled and highly technical workers.

The character of the competition in airframe production which has resulted in the three market sectors has been the consequence of the structure of the market in each of the cases. In the monopsonistic-oligopolistic military market, producers compete actively in product design, proposed product price, and proposed delivery dates. This is because these are factors which are most important in determining who among the competitors will receive the government contracts. Emphasis on product superiority, low cost output,

and early delivery has in consequence caused competitive firms to plow back as much as 65 per cent of profits in recent years into research and development projects and brought on active competition in the factor market for highly qualified scientific and engineering personnel. The superior bargaining position of the monopsonist has enabled it to determine the nature of the product it wants produced, select the firm or firms it wants to produce it, determine the contract terms, set the price of the product it will pay, and finally, re-set the product price at a later date if it thinks a firm has made excessive profits. Because the policy of the services is to pay prices which cover profits as a per cent of production costs, the most profitable point of operation for the military producer is where total costs are the largest. The point of operation is determined, however, by the Government.

Under conditions of bilateral oligopoly in the commercial transport market, producers also compete actively in terms of product design, and delivery dates. Price competition is not so apparent because competitors' products are usually significantly differentiated. Based on anticipated production costs and the estimated extent of the market, producers administer prices on a full-cost plus profits basis designed to yield profits on the model produced beyond the break-even point of operation. The power of the oligopolistic sellers over the larger number of buyers is demonstrated by their ability to administer fixed base prices,

demand favorable contract terms, and get well above average profits. Oligopsonistic buyers exercise their bargaining power by making sellers responsive to their wishes in basic product design and differentiation to suit individual needs. The oligopolists appear to have the stronger position in the bargaining relationship. Prices perhaps have not been higher because of fear of entry.

The buyers' side of the utility aircraft market is one in which buyers number in the thousands and exert no concerted bargaining power over the oligopolistic producers. Because there are a large number of tastes to which producers must appeal, a wide variety of products have been produced. Close substitutes in competition existed in less than half of the cases of the 15 different aircraft models produced by the four leading producers in 1958. Firms engage actively in demand creation by denoting economy of business aircraft ownership and travel relative to travel by common carrier. Oligopolistic power over buyers has resulted in high product prices in relation to production costs with consequent very high rates of profit on investment for the successful firms which have attained a proportionately large volume of sales.

Capital requirements, economies of large scale, technological factors, and inexperience all present serious barriers to new producer entry in the military market. In military production, design competition precedes the award of production contracts. Entry in design competition is

only on government invitation. Government invitation is on the basis of demonstrated ability to produce or past experience. Inexperience, therefore, is perhaps the most restricting barrier to entry in the military market.

These same barriers to entry which exist in the military market also are restrictive to new entry in commercial transport aircraft production. Inexperience again appears to be the most limiting barrier. The only producers of commercial transports are those which have had extensive experience in the production of military aircraft.

Obstacles to entry in utility aircraft production are less imposing. The relatively uncomplicated nature of the product makes technological factors and inexperience less restricting. Capital requirements for initial entry are not excessive as is evidenced by a number of very small producers.

Profits as a per cent of sales after taxes on military production have been low relative to other industries. This is largely attributable to the superior bargaining position of the Government in its ability to set prices. Profits as a per cent of net worth after taxes, however, have been very high. This is attributable to the Government's ownership of approximately two-thirds of the value of facilities in the industry. Profits as a per cent of sales after taxes in commercial transport production is approximately three times as large as in military production. In the absence of data relating to industry investment

connected specifically with commercial transport production, return on net worth may be higher or lower than in military production. In utility aircraft production profit as a per cent of sales after taxes ranged between 3.3 per cent for Beech to as high as 10.2 per cent for Piper in 1957. That same year combined profits as a per cent of net worth of the top 12 military and commercial transport producers were approximately 17 per cent of net worth. Profits on this basis among the top three utility producers ranged between 19 per cent and 36 per cent resulting in part from the superior market power of the utility producers over buyers.

Instead of low profits being a retarding influence on the investment and growth of the industry, as is the general contention of leaders of the industry, if anything high profits have been a stimulating influence. Because profits represent returns to investment which are received by investors, the viewing of profits as a per cent of sales by leaders of the industry is unrealistic in perspective.

The Government has not followed a policy of direct assistance to the civil aircraft manufacturing industry. Indirectly this branch of the industry has been assisted by the provision of navigation aids, airway facilities, airport subsidies, subsidization of air transport companies, and the administration of various controls designed to facilitate safety and efficiency of operation in air transport. The civil aircraft industry, especially the commercial transport manufacturers, have benefited much from

government financed military aircraft research, development, and production.

With the exceptions of the two five-year procurement programs in the 1920's and 1930's, the Government has followed no policy designed to give the industry stability over time. Rather, procurement has fluctuated in response to increases and decreases in international tension.

Largely as a consequence of the Government's willingness to finance the construction of production facilities during World War II, the Government owned two-thirds of the value of facilities in 1958. Post-war policy has been to refrain from government investment in aircraft production facilities where possible, and to encourage private investment by granting privileges of accelerated depreciation.

On contracts the services have attempted to allow profits before taxes of seven to ten per cent of costs. In 1934 the passage of the Vinson-Trammell Act made provisions for profit limitation on government contracts. Since then, notably legislation of 1939, 1942, 1944, 1948, and 1951 have made provisions for renegotiation of contracts on which excess profits were made.

Should the Government decide that there is a need for more private investment in the military aircraft industry than is forthcoming, perhaps an easy way to bring this about would be to allow for more profits on contracts. Competition between firms in the industry places heavy emphasis on technological superiority in product design. Firms with

the technologically superior product realize increased sales and increased profits. To achieve technological superiority necessitates much investment in research and development. Already the industry reinvests profits at a higher rate than any other industry, and if increased profits were allowed there is reason to believe that much of the increased profits would be reinvested by firms in order to maintain or achieve a more favorable competitive position in the industry.

The military aircraft industry can be considered as a sort of "natural oligopoly." In other words, evidence has been presented to indicate that decided economies of large scale are realized in cases where orders for aircraft are sufficiently concentrated among few firms. The result of spreading aircraft orders over a large number of firms would mean increased costs to the Government. As Professor Bain observes:

> . . . as to the sorts of entry barriers which may be legitimately attacked, it was observed that those resting on real economies of large scale plant and firm (whatever their importance) should not and probably could not be removed, because of the adverse effects on efficiency of such removal.[1]

Furthermore, the Government should actively seek to maintain enough producers in the industry capable of large scale production to insure a competitive environment conducive to efficient production and technological innovation. The Government as a monopsonist has the market power to insure

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[1]Bain, Barriers to New Competition, p. 207.

that the public interests are best served by maintaining this type of market structure in the industry.

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